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DIVERGENT PATHWAYS IN SEXUAL DEVELOPMENT[1]

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AMONG the outstanding achievements in biology during the past few years are those relating to the physiology of reproduction. Experimental studies on the identification, analysis, preparation and physiological effects of the so-called sex hormones in the various classes of vertebrates have been particularly noteworthy. It is well known that these internal secretions are responsible for the functional development and activation of the sex glands and their associated structures, for when they are properly administered, either by uniting two embryos together or otherwise, the sexual differentiation and sexual function of the developing individual can often be diverted in either the male or the female direction, as desired.[2]

The effects may be scarcely appreciable or decidedly profound, depending upon the species, the sex and the period of administration. In some of the amphibia complete functional sex reversal is possible. In birds and mammals the effects of treatment with hormones of the opposite sex have been thus far limited to alterations in the sex glands or to the accessory sex organs, or both, without achieving complete functional development. Apparently normal germ cells of the opposite sexual type have been experimentally obtained in the fowl, and the production of fertile sex-reversed individuals in the near future appears to be highly probable.

In certain species of amphibia the sex can be controlled merely by regulating the temperature, by delaying the fertilization of the egg or by other means, but I know of no satisfactory evidence that success

[1] Address of the retiring vice-president and chairman of the Section on Zoological Sciences, American Association for the Advancement of Science, Columbus, December 29, 1939.

[2] B. H. Willier, E. Witschi, L. V. Domm and C. H. Danforth, in "Sex and Internal Secretions," second ed., 1939 (Allen, Danforth and Doisy, editors): Richard Avery Miller, *Anat. Rec.*, 70, 1938.

has ever been attained in the control of sex in man or other mammals. The sex-determining and sex-differentiating mechanisms have been known for some years, but as yet all attempts to direct their activities in favor of one sex or the other have either been without effect or have resulted in abnormalities.

The sex ratios can be modified within certain limits by the selection of suitable hereditary stocks, but the innumerable instances in which it has been thought that sex has been controlled experimentally in man or other mammals seem to have been based on insufficient evidence or chance coincidences.

Some species of invertebrate animals seem to have entirely dispensed with males, the races being continued from generation to generation exclusively by females. Others have only one male for each thousand or more females. In mammals also the male may become superfluous under experimental conditions, since reproduction in the rabbit may now be accomplished by the female alone. Pincus has shown that female young may be born when a few drops of a salt solution have been substituted for the conventional father. With that exception, the numerous techniques that have been recommended in recent years seem to have been no more successful in preconceptional sex control than those which Aristotle wrote were in vogue in his time. It must not be concluded, however, that the eventual discovery of a practical technique which will fulfil the desires of prospective parents and animal breeders is improbable.

Some of the sex hormone preparations have already proved helpful in overcoming the defects of imperfectly functioning organs. Their administration to adolescents or adults often has a considerable effect on the nervous system and on the individual's subsequent behavior. Allee has found that the synthetic male hormone testosterone propionate will make a timid hen domineering and cocky. The hormones of both sexes promise to be of much service in the medical practice of the future. But as a boon to the elderly in arresting senility or as a means for reconditioning or rejuvenating the superannuated they seem not to have worked out so well as was predicted several years ago.

We know that partial or complete sex reversal of aberrant individuals of all groups of vertebrates occasionally occurs in nature, either by the failure of the sex-differentiating mechanism to function normally or as the result of some pathological condition in later life. That this is possible may be considered proof not only of the double sexual potency of the undifferentiated embryo but the retention of such potency even after functional differentiation. The sex mechanism is so labile that it can be diverted in either direction by appropriate activating and inhibiting agencies. Experimentally, these may be either chemical or physical.

A functional change of sex takes place normally in a few species of fishes, in many kinds of invertebrates and in some plants. In some of these this occurs not merely once but several times. The transition stages between two sexual phases are similar to those observed in cases of intersexuality and sex reversal in insects and vertebrates. Consequently, an examination of the sexual conditions in a few such forms may be helpful toward an understanding of the general problem which is now under discussion. We shall find that in spite of their diverse manifestations the sexual phenomena of all multicellular animals are based upon a few general principles. Primarily, we shall observe that the organs of the two sexes or sexual phases in both vertebrates and invertebrates have a similar origin from sexually undifferentiated primordia. The diversities result from different activating agencies.

We may first consider an example of *consecutive sexuality* and the problems relating to the influence arising from the association of two or more individuals.

Let us select for this purpose the marine snails belonging to the genus Crepidula, although the representatives of other genera would serve as well. In these snails each of the young individuals functions as a male for a time and afterward changes to the female phase. The male phase thus represents the juvenile condition, the female phase continuing through the remainder of the individual's life. This type of sexual change is strictly hereditary and takes place in all normal individuals. Sex reversal in these snails is consequently comparable with metamorphosis from the larval to the adult condition in insects and amphibia, and like such metamorphosis the juvenile phase can be abbreviated or prolonged experimentally, but the sequence of the two phases can not be reversed.[3]

At the beginning of the female phase the instinctive behavior changes and the individual whose previous activities were so characteristically masculine then becomes strictly sedentary; she receives her mate, deposits her eggs and protects her developing young.

Although this sexual sequence is experienced by all normal individuals, the accentuation and duration of the male phase are highly variable and dependent both upon the hereditary composition of the individual and the environmental conditions. There appear to be two intergrading types of male-phase individuals, as shown by the relative abundance of primary ovocytes in the sex gland and by the behavior of the respective individuals. Those with the more numerous ovocytes, the so-called hermaphroditic males, exhibit a less masculine behavior in that they are less

[3] W. R. Coe, *Jour. Exp. Zool.*, 77, 1938; *Jour. Morph.*, 63, 1938; *Biol. Bull.*, 75, 1938; H. Ishiki, *Jour. Sci. Hiroshima Univ.*, Ser. B, Div. 1, 4, 1936; 6, 1939.

active in their search for females and are less likely to attach themselves in the mating position. They also begin the sexual change at an earlier age and increase in size much more rapidly than those more masculine individuals, or "true males," which have fewer ovocytes and which when isolated may remain more or less restless for several months without changing their sexuality.

One of the environmental conditions which influences the duration of the male phase is opportunity for association with an individual in the female phase. Solitary males or males which are isolated when young usually, but not invariably, undergo sexual transformation much more promptly than those with female associates. In nearly all the species studied such association both accentuates and prolongs the functional male phase, although in none of them is association necessary for the realization of that phase.

It must be admitted that Crepidula has not yet divulged the secret by which this is accomplished. The explanation seems to depend upon the stimuli which the male receives through his sense organs and the associated internal changes occurring at the time of mating. It seems quite unnecessary to assume the transfer of any specific masculinizing substance of hormonal nature from the body of the female to that of her mate.

Adverse metabolic conditions such as abnormally high temperature, lack of oxygen, deleterious substances in the water or extensive parasitism terminate the male phase without inaugurating the female phase. If favorable conditions are later restored the female phase follows, but not otherwise. In some species under adverse conditions the functional male phase may be long delayed and in exceptional cases the female phase may become functional after an aborted male phase.

The transition period between male and female phases may be either brief or prolonged, depending upon the individual, the environment and the species. In all cases the intersexual stages are closely similar to the sex intergrades which appear during the developmental processes of insects and other dioecious forms, including vertebrates, with unbalanced sex-differentiating factors or of those undergoing sex reversal.

In terms of genetics the sexuality of Crepidula would imply homozygosity of both male and female sex-determining genes, with modifying factors which control the initial expression of the male phase, together with associated factors for the termination of that phase and the inauguration of the female phase after a certain stage of physiological maturity is reached. The hereditary mechanism responsible for this consecutive sexuality is in some respects comparable with that which operates during the change from juvenile to adult plumage or pelage in birds and mammals.

We may now inquire as to how this change of sex is brought about. A study of the embryological development shows that although the primordial germ cells are early set apart from the other organ-forming groups of cells they show but little activity until after all the other organ systems have become functional. In the meantime the primordia of the accessory male organs have been formed by the organizing potency of the body in conformity with the plan of organization peculiar to the male phase of the species. The early sex gland is usually differentiated into the two types of primary germ cells characteristic of the two sexes.

As soon as the physiological conditions become suitable the male constituents of the sex gland resume activity. Spermatogenesis begins and at the same time, or earlier in some species, the primordia of the accessory male organs become activated and eventually attain functional development. We have no satisfactory evidence at present as to the nature of the activating agency, whether the induction results from the action of local organizing centers or whether hormones are secreted by more distant groups of cells.

The functional male shows no indication of any female characteristics, as do the males in most vertebrates, except for the ovocytes in the gonad. And yet the individual is genetically determined for femaleness and the male is but the first stage toward that genetically completed individual represented by the female phase.

After a more or less lengthy period of masculine control of the reproductive processes the influence of the female-differentiating genes becomes evident. The ovarian constituents of the sex gland then become active, and thereupon all the spermatogenic cells are destroyed. Then the accessory male organs which had been so perfectly formed are remodeled into organs adapted to the reproductive requirements of the female phase. In some species there is an overlapping of the two sexual phases, but in certain individuals of other species both the sex gland and the accessory sex organs return to a simplified or neutral condition before they are redifferentiated into the female type.

In these sexual changes we witness a long series of developmental processes indicative of the successive responses of the body cells to the activating agencies of the genetic constituents of the nuclei, as well as to the mutual influences of the associated cells. The hereditary organization pattern of full maturity is realized only after the sexual transformation has been completed.

A different aspect of the influence of association on sexuality is shown by a species of chaetopod annelid belonging to the genus *Ophryotrocha,* common alike on European shores and on our Pacific coast. In this

species also each of the young worms functions for a time as a male but usually changes to the female phase on reaching a certain size. Under favorable conditions the female phase may continue for the remainder of the individual's life, as in Crepidula, but otherwise the original male phase is resumed.

It has been known for nearly half a century that when the head and a few adjoining segments are severed from the rest of the body of an individual in the female phase it often happens that both fragments revert to the juvenile male phase and produce sperm from the undifferentiated germ cells which they contain. For some individuals a second or a third operation may be necessary. The posterior fragment then dies, while the anterior end regenerates into a small worm similar in most respects to a young male at first sexual maturity. Under favorable conditions this rejuvenated male later changes again to the female phase, and these procedures may be repeated many times. Or the male phase may be continued for long periods by removing the posterior segments with sufficient frequency.

Starvation or other adverse conditions, including various chemical modifications of the sea-water, may likewise cause the functional female to resume the male phase or cause that phase to be long retained. The accumulation of excretions also acts as a masculinizing agency, presumably by interfering with normal nutrition. It has been observed[4] that when two females are placed together in close confinement the more vigorous or more dominating Amazon may obtain a male companion either by biting the other female into two or by devouring all the available food. The more susceptible of the two females may thereupon undergo sex reversal and then, functioning as a male, is available to stimulate ovulation in the remaining female and to fertilize her eggs as they are deposited. After securing her mate she may in some cases keep him in the male phase indefinitely, but more often the recently transformed male again changes sex and becomes in turn the dominant female of the pair, whereupon the sexual relations will be reversed.

In contrast with the condition in Crepidula, such germ-cells as are in process of development during one sexual phase continue maturation in association with those of the opposite type in the newly transformed sex. Self-fertilization may result. It is thus evident that the morphologically undifferentiated germ cells are sexually neutral and that their differentiation is controlled by the conditions within the parent's body. The precise nature of the controlling agency, whether nutritive or hormonal, is still unknown.

[4] M. Hartmann and W. Huth, *Zool. Jahrb. Abt. all Zool.*, 56, 1936; M. Hartmann and G. v. Lewinski, *Zool. Jahrb. Abt. all Zool.*, 58, 1938.

Other aspects of this problem of the influence of association on sexuality are found in various examples of parasitism. We must consider the effects of the host on the parasite, of the parasite on the host and of the parasites on each other. First there is the influence of the host on the parasite of the same species. A classical example of this is found in the gephyrean worm Bonellia. Here the male is a relatively insignificant creature, perhaps a thousandth the size of the female on which he is parasitic. After the eggs are shed into the water some of the free-swimming embryos settle down upon the outstretched proboscides of female Bonellias, while others come to rest upon the surrounding sea bottom. It has been known for many years that about 85 to 90 per cent. of the embryos which become attached to the proboscides transform into males, while approximately 95 per cent. of those that find no females become females themselves.

If the larvae are removed from the proboscis after a brief but not too brief period of attachment many intersexual individuals result, since male differentiation may have proceeded too far for normal female development to be possible.[5]

Precisely how the masculinization of the larva is accomplished by its attachment to the proboscis is still uncertain. But it is known that extracts of the proboscis or of the intestine or of the body wall are likewise effective. They are also more or less toxic to other small organisms. Herbst and others have found that many different chemical modifications of the sea water produce the same result. A small amount of a copper or potassium salt, a trace of acid or a decrease in the magnesium content of the water are some of the modifications that have an effect similar to that produced by the proboscis secretion. It is the external influence, then, that determines which of the two alternative paths of development most of the sexually undifferentiated larvae shall follow.

Some of the developing females assume certain characteristics of the male and may even produce sperm before transformation to the definitive female condition. Consequently, it has been suggested that each individual inherits a tendency toward consecutive sexuality and that the female phase is inhibited in those individuals that function as males. Such inhibition is accomplished in nature by the secretion of the proboscis and experimentally by chemical modifications of the water. As mentioned for Crepidula and Ophryotrocha, it appears that relatively small chemical or physical changes in the environment are sufficient to prevent the differentiation of female sexuality, while allowing full expression of the hereditary factors for maleness. Conversely the male phase is usually, but not always, abortive without the stimulating effect of the proboscis secretion.

[5] F. Baltzer, *Rev. Suisse Zool.*, 38, 1931; 39, 1932; 44

Here again there appear to be diversities in the genetic endowment of different individuals. Usually 5 to 15 per cent. of the embryos persist either in male or in female development in spite of environmental conditions which control the sexuality of the others. These diversities may be explained likewise on the assumption that modifying factors for sexuality are associated with homozygosity in both male and female sex-differentiating mechanisms.

We may next consider the influence of the host on parasites of a different species. This is well illustrated by some of the nematode worms in which the sexual cycle covers two generations. One of these is free-living and of separate sexes, while the other is parasitic and is functionally hermaphroditic and self-fertilizing. The chromosomal composition of all individuals of the parasitic generation is female, and the early gonad is of the female type. After a period of parasitism, however, the gonad becomes hermaphroditic and functions as such.

Zoological literature contains numerous reports concerning the influence of the host on the sexuality of the parasite as well as of the effects of parasites on each other. Hermaphroditism is characteristic of many groups of parasites, but in some forms that are of separate sexes the sex mechanism is so evenly balanced that the sex may be controlled experimentally, in some cases merely by regulating the number of parasites present. The amount of nutrition available and the effects of excretion products appear to be the controlling factors.

Another aspect of the problem of sexuality as related to parasitism concerns the effects of external parasites on the host in decapod crustacea. In extreme cases the sex glands of the host are almost completely absorbed. Later, after the period of parasitism is ended, the remaining part of the gonad may resume activity. If the host is a male there may be partial or complete transformation to a female condition.

If we may assume either that some of the females have a tendency toward a juvenile male phase (of which there is some evidence) or an antagonistic action of the male and female constituents of the gonad, the removal of the functional portion of the spermary would allow the inactive ovarian elements to assume dominance. The sexuality would then be reversed, and female external characteristics would appear after molting. It seems quite unnecessary to assume the secretion of any specific feminizing substance by the parasite.

The associative influence of dense populations and their accompanying excretions, as well as of other environmental conditions, in controlling sexuality or, more strictly, the method of reproduction is well shown by some of the cladoceran crustacea and rotifers. Some of these can be cultivated for a hundred or more generations as exclusively parthenogenetic females. But males and sexual females can be obtained at any time merely by suitable changes of the temperature, by altering the nutritive conditions or by overcrowding and allowing the accumulation of excretory substances. For a brief period the water in which the animals have been cultured contains the excreted substances, whatever they may be, and controls the sexuality of other individuals of the same species. A decreased metabolic condition is suggested as the possible determining factor.[6]

In some of the algae likewise the filtrate from sexual cultures determines the sexuality of other gametes that may be placed in it.[7]

It has been reported recently that one species of fungus produces four specific activating substances, two by each of the two sexual types. These are secreted in sequence, and all are thought to be necessary for the consummation of functional sexuality.[8] It thus appears that both algae and fungi produce sexual substances of such specific nature that they may be said to be strictly comparable with vertebrate sex hormones.

The examples that I have given as showing the influence of one individual on the sexuality of another must be considered as exceptions to the vast majority of organisms in which no such influence is found. Many of the latter have separate sexes, with genetic sex-differentiating mechanisms that are so accurately adjusted by heteromorphic sex chromosomes that sex reversal is not known to occur. Others are homozygous hermaphrodites, and still others either change their sex during life or have so unstable a sexual condition that their genetic sex can be more or less completely reversed either by natural environmental conditions or experimentally. A few examples of these may be mentioned.

Consecutive sexuality similar to that noted for Crepidula and Ophryotrocha is of wide distribution in invertebrate animals, including mollusks, annelids, echinoderms, nemerteans and crustaceans, as well as in some plants and in a few species of fishes. Most of the invertebrates with this type of sexuality experience but a single change of sex, usually from male to female. An overlapping of the two sexual phases frequently produces a brief period of functional hermaphroditism, at which time self-fertilization may

1937; C. Herbst, *Arch. Entw. mech.*, 135, 1936; R. Goldschmidt, *Genetica*, 20, 1938; *Am. Nat.*, 72, 1938.

[6] A. M. Banta, *Am. Nat.*, 71, 1937; Clifford H. Mortimer, *Zool. Jahrb, Abt. all Zool.*, 56, 1936; Kaj. Berg, *op. cit.*, 57, 1937.

[7] M. Hartmann, *Arch. f. Protist.*, 89, 1937; B. Hammerling, *Fort Zool.*, 1, 2, 1937; Franz Moewus, *Jahrb. wiss. Bot.*, 86, 1938; *Naturwiss.*, 27, 1939.

[8] John R. Raper, SCIENCE, 89, 1939.

occur. Other representatives of the same groups may experience a *rhythmical sexuality*, with regularly alternating male and female phases.

All the species that have been most fully studied agree with Crepidula in having two intergrading types of males, the so-called hermaphroditic males, which soon change to females, and true males. In the former the gonads often have a more or less continuous basal layer of ovocytes, with the spermatogenic cells superimposed near the lumen. This condition resembles the cortical and medullary portions of the gonads of many of the vertebrates. In the true males many or all of the ovocytes in the primary gonads are eliminated, and such individuals retain the male phase indefinitely but not necessarily through the entire life span.

There are some invertebrates in which the sexuality is so labile that it is impossible to predict during one reproductive season the sexual phase which the individual will assume at the next. This type of *alternative sexuality* is illustrated by the commercial oyster of the Atlantic coast, which is seasonally of separate sexes with a strong tendency toward protandry. The proportion of males at the first reproductive period varies from 70 to more than 90 per cent. at different localities and under various environmental conditions.

Following the first reproductive season many of the young males change to females, whereby the sex ratio becomes more nearly equal and there are as many females as males in populations four or more years of age. In the meantime some of the females have changed back to males and then to females again.[9] It is thought that the population consists of two hereditarily distinct types of individuals with reference to their rhythmical tendency and their response to environmental influences.

This alternative expression of sexuality is closely paralleled in some of the flowering plants and in certain species of plants belonging to the lower orders.

In a few representatives of unrelated groups, as nematodes, gastropods, pelecypods, crustacea and fishes, the fully mature individuals are strictly of separate sexes, although all or nearly all the young first function as males. In these species the genetic males (true males) continue to function as such throughout life, while the genetic females (hermaphroditic males) function as males when young and as females thereafter.

More or less numerous representatives of nearly every phylum of invertebrates and of every phylum of plants are functionally hermaphroditic. Here there is no incompatibility between the two types of sex organs, and each adult individual may function simultaneously both as male and as female. Not infrequently, however, this condition is preceded by a brief period of maleness or, occasionally, of femaleness. In some of these species the extent of protandry is increased by unfavorable conditions and can be controlled experimentally.

Incomplete sexual differentiation or intersexuality may result from the crossing of different species or of different geographical races of the same species. While each species or race may have sharply differentiated sex mechanisms, the hybrids often inherit a combination of male as opposed to female determining factors so nearly equal that neither is completely dominant, resulting in an intersexual, sterile condition. Both male and female characteristics may begin development simultaneously or, as Goldschmidt has shown so clearly in the classical example of the gipsy moth, those of one sex may be dominant in the early stages of development and those of the other sex later.

Other sexual abnormalities of similar character may result from endocrine disturbances, irregularities of chromosomal distribution or mutant autosomal genes which interfere with the normal action of the sex-differentiating mechanism.[10]

When closely related species or geographical races of unicellular algae are crossed a series of intergrading sexual types may be produced. Each of these will conjugate readily and form viable zygotes with all other types, including those of the same sex, which are not too closely similar. Sexuality is therefore not absolute but relative, with perhaps several grades of maleness and of femaleness.[11]

Divergent manifestations of sexuality with balanced mating types are also found in local races of unicellular animals. The 16 types which are already known in one common species of Paramecium may be cited as an example.

The question naturally arises as to what bearing all these manifestations of sexuality may have on current theories of sex determination. The answer is that they seem to be entirely consistent with the view that the prospective sexuality of the individual is dependent upon the quantitative balance of the male as opposed to the female factors in the hereditary mechanism. Whether this mechanism primarily resides exclusively in the chromosomes has been a fruitful source of discussion, but undoubtedly the cytoplasm is the agency through which the cellular differentiation is effected.

There are certain types of sexuality that can be explained most satisfactorily on the assumption that the peculiarities of the cytoplasm are such as to in-

[9] W. R. Coe, *Biol. Bull.*, 74, 1938; P. S. Galtsoff, *Biol. Bull.*, 74, 75, 1938; *Anat. Rec.*, 72, Suppl., 1938.

[10] G. A. Lebedeff, *Genetics*, 24, 1939.

[11] M. Hartmann, *Zeits. f. ind. Abst. u. Vererb.*, 54, 1930; Franz Moewus, *Jahrb. wiss. Bot.*, 86, 1938; *Naturwiss.*, 27, 1939.

hibit the full expression of the chromosomal inheritance. It is not improbable, however, that some of these cytoplasmic peculiarities are themselves the result of nuclear activities, while others are inherited directly through certain of the constituents of the cytoplasm and are only indirectly subject to nuclear control.

All the diversities that I have mentioned may be referred to the homozygosity or heterozygosity of the primary sex factors, with their associated modifying factors for the activation or suppression of either the male- or female-determining components at certain stages of embryological development or in harmony with different degrees of physiological maturity. They are all responsive to environmental conditions both within and without the body of the organism.

Internal Secretions

And, finally, the influence of internal secretions on sexuality should be considered. The presumably universal occurrence in vertebrates of hormonal substances necessary for the development and functional activity of the sex organs would seem to imply that secretions of a similar nature must be present in invertebrates. But as yet conclusive evidence to that effect has been found only in crustacea and insects.

It is well known that the removal or transplantation of the gonads in larval insects is without effect on the sexual development or the sexual instincts of the adult. Sex mosaics (gynandromorphs) may have both male and female secondary sexual characteristics perfectly differentiated locally, associated with gonads exclusively of either sex. Hence the evidence now indicates that, although the primary gonads have bisexual potencies, the primary sex-differentiating agents in the insects have only a local influence and are not discharged into the blood. In some species, at least, true hormones supplement these agents in the functional development of the organs. Goldschmidt has suggested that in the moth the activating agent may be released at the base of the imaginal disk from which the part is formed and that its influence then spreads over the disk in the manner of a consecutive embryological organizer.

In most invertebrates there is only a single set of primordia for the accessory sex organs, and these are homologous in the two sexes. The organs which they form may differ greatly, however, presumably because the activating agency in the male is of a different nature from that in the female and activates different parts of the primordia. It is also probable that in some animals the two agencies are differently localized. In individuals with consecutive sexuality the parts peculiar to the primary sexual phase may be reduced to a simplified or neutral condition at the time of sexual transformation. The system is later redifferentiated by the agencies of the succeeding sexual phase in harmony with the functional requirements of that phase. In hermaphrodites some of the parts of the single set of primordia become differentiated into organs of the male type at the same time that other parts are forming the female organs. Thus the activating agencies of both types of sexuality react either consecutively or simultaneously upon those parts of the primordia that have been differently sensitized or localized for their reception.

In the higher vertebrates, on the other hand, the primordia of most of the accessory sex organs are formed in duplicate sets, one set being sensitized for reaction with the male-differentiating agency and the other set with the female agency.

Witschi and others have presented evidence that the cells of the two primary components, cortex and medulla, of each of the sex glands in amphibians and birds secrete antagonistic hormones, the secretion from each component tending to activate the germ cells of that component and to suppress those of the other.[12] Since the cortex represents the prospective female part of each sex gland and the medulla the male part, the sexuality of the individual will depend upon whether the cortex or the medulla becomes dominant. And this is determined both by the genetic composition of the cells and by the environmental conditions. The first effect of the sex hormones is upon the development of the sex glands themselves and later, after diffusion into the blood, the hormones activate that one set of the duplicate accessory sexual primordia that has been chemically sensitized for their reception.

The functional sexuality of the sex gland and then of the appropriate accessory organs are thus under the control of the specific sex hormones. These hormones evidently have no organizing potency in the initial formation of either the sex glands or their associated organs. They merely activate or inhibit the appropriate parts already prepared by the organizing properties of the body as a whole and maintain the functional sexuality of the adult.

Not infrequently, however, the relations seem to be more complicated. Under experimental conditions the results are sometimes contradictory, since the administration of large amounts of the hormones of either sexual type may produce intersexuality or incomplete hermaphroditism by inducing the development of both male and female accessory sex organs simultaneously.[13] In some cases the effects are more

[12] R. K. Burns, Jr., *Anat. Rec.*, 63, 1935; *Am. Nat.*, 72, 1938; E. Witschi, *Biol. Rev.*, 9, 1934; B. H. Willier, T. F. Gallager and F. C. Koch, *Physiol. Zool.*, 10, 1937.

[13] R. K. Burns, Jr., *Jour. Morph.*, 65, 1939; R. R. Green, H. W. Burrill and A. C. Ivy, *Am. Jour. Anat.*, 65, 1939; C. D. Turner, *Jour. Morph.*, 65, 1939.

pronounced with the male than with the female type of hormones. A feminizing effect may also follow the administration of male hormones to males in amphibia. reptiles and mammals or to developing male chicks. To explain these double effects Burns has suggested that the introduced substances either may be changed chemically in the body or may stimulate the secretion of the normal heterotypic hormone. It is well known that the pituitary and other endocrine glands are closely associated physiologically with the sex glands.

Transplantation experiments prove that the primary germ cells of the vertebrates, like those of the invertebrates, are bipotential and that their differentiation into the germ cells characteristic of the one sex or of the other is controlled by the associated tissues. They will become of the male or of the female type depending upon their position within the sex glands; male if situated in the medullary portions and female if in the cortex. Since only one of these two portions is normally retained in each of the functional sex glands of vertebrates with separate sexes, the germ cells remaining are all of the same sexual type. If both portions develop simultaneously hermaphroditism results, but if either one is inhibited for a time and later becomes functional, consecutive sexuality of the one type or of the other, as mentioned for certain invertebrates and fishes, may ensue.

Functional activity, however, is dependent upon agencies additional to those which govern the differentiation of the organs; it requires the mutual interaction of the organs themselves with other secreting and reacting systems, including the nervous system. Only then is physiological sexuality realized and only then do the sexual instincts become operative.

The realization of functional sexuality, therefore, requires the participation of a long series of hereditary reaction systems which are activated one after the other in orderly sequence under the influence of suitable external and internal conditions. The environmental requirements may change during successive stages of development. Each developmental event as it occurs is a response to a preceding action and in turn initiates the one that is to follow. If any one of these reactions fails to occur because of either hereditary or environmental deficiency functional sexuality is not realized. The individual is sterile, and its line of descent comes to an end.

OBITUARY

WILLIAM SNOW MILLER
1858–1939

DR. WILLIAM SNOW MILLER, emeritus professor of anatomy at the University of Wisconsin, died at Madison on December 26, 1939, in his eighty-second year after a brief period of illness and inactivity. Although death came in the fullness of years it appeared especially untimely in one with his mental alertness and scientific activity. In the seventeen years since his retirement from active teaching, Dr. Miller's accomplishment has been such that it might well be the envy of a much younger man. With a daily routine of a morning spent in the laboratory and an afternoon in his well-equipped library, he has furthered the two great interests of his life, the anatomy of the lung and medical history. In the former, his researches of a period of almost a half century were consolidated in his monograph "The Lung," published in 1937. This book had been so eagerly awaited that a first printing of 1,500 copies was exhausted in two weeks. This book he wisely regarded as not the last word on the subject but as a foundation upon which others might build. This work he would leave as his monument.

Dr. Miller's interest in the cultural side of medicine led to the assembling at his home of a library, unusually rich in the classical anatomical works, in medical biography and history and in general medicine. During the past thirty years there has been held in this library a bi-weekly seminar in the history of medicine. This was at first composed of a select group of interested students, and later, after his retirement from active teaching, of colleagues of the medical faculty. Numerous published contributions to the history of medicine have resulted from this seminar. In later years Dr. Miller's own interest has been centered largely in early medical conditions in Wisconsin. Through his efforts a memorial tablet to William Beaumont was set up at Prairie du Chien, where so many of the observations on Alexis St. Martin were made.

It is, however, not only as a skilled, patient and persistent investigator and as cultivator of the historical field that Dr. Miller is to be remembered. He was also a teacher of distinction. In his earlier years at Wisconsin he came into intimate contact with the premedical students with whom he worked. To them he taught histology, neurology, comparative anatomy, topographical anatomy and embryology. Given this extended association with members of small classes, his influence on his students was easily greater than that of any other faculty member. His high ideals, his scientific curiosity and his beautiful, precise laboratory technique were a living example and inspiration to them. That he was a strict taskmaster in requiring of his students similarly honest, clean-cut, independent work did not prevent but rather resulted in a devoted following of young medical men who main-

tained for him an admiration and affection which lasted throughout his life. In the success of these men lay his greatest pride.

While the larger classes and the restriction of his teaching to the subjects of histology and neurology, after the establishment of the medical school, lessened his contact with students, it hardly diminished his influence, for he remained always a living ideal and the noblest ornament of the medical school.

Dr. Miller was born at Stirling, Mass., on March 29, 1858, the son of the Reverend William and Harriet Emily (Snow) Miller. With the foundation of his education laid in this cultured home, he attended Williston Academy at East Hampton, Mass. Afterward following a preceptorship under Dr. C. H. Hubbard at Essex, Conn., he entered Yale Medical School, from which he was graduated M.D. in 1879. Following graduation, he studied under Dr. Francis Delafield at the College of Physicians and Surgeons in New York for several months and then returned as laboratory instructor under Dr. Benjamin Silliman, Jr., at Yale. An infection, received at a post-mortem examination, led to a long illness. Upon recovery he deserted the laboratory for medical practice, which he carried on first at Clinton and later at Southbury, Conn.

His great tribulation, slowly developing deafness, drove him from medical practice back to the laboratory in 1889, when he became pathologist to the City and Memorial Hospitals in Worcester, Mass. A year later he became a fellow at Clark University, where he came under the influence of Dr. F. P. Mall and began his study of the lung. With the disruption and dispersion of the scientific faculty in 1892, Dr. Miller accepted an appointment as instructor in zoology at the University of Wisconsin. There he spent the rest of his academic life, with the exception of three years, one of which was spent in Leipzig and two at Johns Hopkins. He became emeritus professor of anatomy in 1924.

The honorary degree of doctor of science was conferred upon Dr. Miller by the University of Cincinnati in 1924 and by the University of Wisconsin in 1926.

Other honors came to him. He was honorary member of the National Tuberculosis Association and in 1934 the association honored him with its Trudeau medal. He was an honorary member of both the Connecticut and Wisconsin Medical Societies. He was a Harvey Society lecturer in 1924. He was a fellow of the American Association for the Advancement of Science; the American Medical Association; the American Association of Anatomists (vice-president, 1909); American Association of the History of Medicine; Medical History Society of Chicago; Milwaukee Academy of Medicine; Wisconsin Academy; Deutsche Gesellschaft für Geschichte der Medicin und der Naturwissenschaften; Société Internationale d'Histoire de la Medicine; Union International contra la Tuberculose.

Dr. Miller was twice married. His first wife, Carrie M. Bradley Miller, of Clinton, Conn., died in 1901. In 1912 he married Miss Alice Burdick, of Madison, who survives him.

C. H. BUNTING

RECENT DEATHS

DR. ARTHUR WHIPPLE SMITH, since 1920 professor of mathematics at Colgate University, died on February 11 at the age of sixty-three years.

REV. FRANCIS J. WENNINGER, professor of zoology and dean of the College of Science of the University of Notre Dame, died suddenly on February 12. He was in his fifty-second year.

DR. RALPH DANIEL REED, chief geologist of the Texas Company, Los Angeles, past president of the American Association of Petroleum Geologists, died on January 19 at the age of fifty-one years.

COLONEL R. E. CROMPTON, of London, pioneer electric lighting engineer, twice president of the Institute of Electrical Engineers, died on February 15 at the age of ninety-four years.

SCIENTIFIC EVENTS

A MINERAL MAP OF CANADA

THE diversity of mineral wealth of Canada and the wide-spread distribution of the mineral resources of the country are shown in a new mineral map of the Dominion issued recently by the Department of Mines and Resources, Ottawa. The map, which is on a scale of 100 miles to the inch, measuring 18 inches by 35 inches, shows the active sources of supply of the metals and minerals being produced in Canada, together with the known, but as yet non-productive sources of supply. On it are shown also the locations of lode gold and placer gold areas; of all lead, zinc, copper, nickel, precious metals, iron and steel and other metallurgical plants; and of cement plants, petroleum refineries and fertilizer plants. Shown in colors are the geological provinces of the Dominion, the largest and most important of which, from the viewpoint of mineral production, is the Canadian Shield, which covers an area of approximately 2,000,000 square miles.

Compared with a similar map issued several years ago, the new map brings to light much evidence of the rapid headway that has since been made in Canadian mining. One instance is the appearance of many new

fields of mining activity, among them being the radium-silver operations at Great Bear Lake, and the new gold camp in the Yellowknife River area in the Northwest Territories. Another is the appearance of the air routes serving the mining fields across the Dominion. Few such services had been developed when the former map was issued. One of the longer of the air routes is shown extending from Edmonton to Resolution south of Great Slave Lake, from where it branches off to Aklavik and to Port Radium and Coppermine. Another extends from Edmonton to Whitehorse and other centers in Yukon.

Most of the principal metals and many of the principal non-metallic minerals are being produced in the Dominion, some of them, including sulfur, rock wool, nepheline syenite, radium and magnesitic dolomite being fairly recent additions to the list.

ENTOMOLOGY AT DARTMOUTH COLLEGE

THE establishment at Dartmouth College has been announced of the Henry Clinton Fall Fund for the promotion of the study of entomology. The fund is a memorial to the late Henry Clinton Fall, entomologist of Tyngsboro, Mass., from whose estate a capital fund of $5,000 has been received by the college. So that income for entomological research may be available at once, the bequest provides an additional amount for immediate expenditure.

The first use of the Fall Fund by the college will be to purchase entomological equipment for the Dartmouth College Museum, which plans a survey of insect fauna of the Hanover region as part of its program to promote knowledge of the economic entomology of the region. The survey will also result in important additions to the 40,000 specimens already possessed in the various entomological collections at Dartmouth.

Dr. Fall, who died last November in his seventy-seventh year, was an authority on American beetles. During the research which he carried on in addition to his work as high-school teacher, he collected some 200,000 mounted specimens. A graduate of Dartmouth in 1884, he was honored with the degree of doctor of science in 1929. He was a member of the permanent committee of the International Congress of Entomology at Brussels, and also held membership in the Entomological Society of America, the American Association for the Advancement of Science and the American Academy of Arts and Sciences.

The entomological collections in the Dartmouth College Museum have grown in the last ten years from virtually nothing to more than forty thousand specimens. Three quarters of these were acquired in 1929 through two gifts—the John Dexter Locke collection of moths, butterflies and beetles, numbering over 25,000 specimens, which was presented by Mrs. Moses Dyer Carbee, of Haverhill, N. H., and the Charles Pliny Whitney collection of North American butterflies and moths, containing nearly 5,000 specimens, which was presented by Dr. Herbert Stillman Hutchinson, Dartmouth, '75, and recently transferred from the department of biology to the museum. The remaining 10,000 specimens are the result, in large measure, of the collecting activities of the staff and students, directed chiefly to the filling in of groups of insects not represented in these two collections. Numerous small collections have also been presented in recent years, and the foundation for a good general collection now exists.

Until now, however, the growth and development of the collections have been severely handicapped by insufficient storage containers and other equipment, and field work has necessarily been curtailed. The income from the Henry Clinton Fall Fund will be used primarily for this purpose, so that storage and study facilities may keep pace with the growth of the collection.

While the aim of the museum is to build up a general teaching collection of insects, field work will naturally be chiefly in Vermont, New Hampshire and Maine, where a thorough survey is being planned. In so far as New Hampshire is concerned, the museum will work in close cooperation with the recently organized Biological Institute of the University of New Hampshire, where a comprehensive survey is being organized.

REPORT OF THE PRESIDENT OF THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

ON June 30, 1939, the Carnegie Foundation for the Advancement of Teaching had resources of $26,917,932. During the preceding year it received $998,714 as income from securities. It disbursed $1,963,279 on account of retiring allowances and widows' pensions, $61,898 for studies conducted in its Division of Educational Enquiry and $91,350 on grants for special research projects carried forward at American universities and by various bodies and associations.

Pertinent facts concerning the retiring allowances and widows' pensions of the foundation for the year ended June 30, 1939, are as follows:

Year's total expenditure for retiring allowances and pensions, $1,963,279.

Increase over year ended June 30, 1938, $2,073, as contrasted with $38,372 for the preceding year.

New allowances and pensions begun, 174, as contrasted with 170 during the preceding year.

Retired teachers receiving new allowances, 123.

Average amount of new allowances, $971.12.

Average age of 123 teachers retired during 1938–39, 68.17 years.

Average length of service of 123 teachers retired during 1938–39, 38.37 years.

Total allowances and pensions in force, 1,496 as contrasted with 1,414 in the preceding year.

Widows receiving new pensions, 51.

Total allowances granted, 1906–1939, 2,965.

Total expenditures for retiring allowances and pensions, 1906–1939, $36,694,421.30.

Since 1905 the foundation disbursed more than $36,694,000 for retiring allowances and widows' pensions, or more than double its General Endowment Fund. Of these disbursements, Harvard University has received more than $2,985,000; Columbia University, $2,645,000; Yale University, $2,218,000; Cornell University, $1,671,000; the University of Michigan, $1,227,000, and the University of California, $1,062,000.

The report discusses the operation of thirty-one research projects at a cost, during the fiscal year 1938–39, of $91,350.

The cooperative arrangement between Carnegie Corporation of New York and the Carnegie Foundation for the Advancement of Teaching respecting projects in the field of higher education has now been in effect for about fifteen years. A series of 148 grants amounting to $1,449,393 have been made by the corporation for eighty-five projects, of which fourteen, involving thirty-four grants, have been carried on in the offices of the foundation, and seventy-one projects involving $1,087,350 in 114 grants have been carried on under the auspices of forty-one other educational institutions or bodies. To these the foundation has allocated and transmitted the funds provided by the corporation.

SUMMER CONFERENCES ON ASTRONOMY AT THE HARVARD OBSERVATORY

THE fifth session of Summer Conferences on Astronomy will be held at the Harvard Observatory from July 1 to August 10. It is believed that many investigators and teachers will welcome the special opportunities for discussion and research available during the six-week session. Visitors who wish to use the plate collection or the instrumental equipment of the observatory will be accommodated to the greatest possible extent. Colloquia will be conducted twice each week by staff members and visiting investigators.

The conferences will include:

Topics in Celestial Mechanics, Professor Dirk Brouwer, Yale University. A discussion of the theory and application of planetary perturbations.

The Internal Constitution of the Stars, Dr. T. E. Sterne and Dr. Martin Schwarzschild. An application of the laws of physics to stellar interiors and a comparison of the results with observation; an introductory course.

Introduction to Astronomical Optics, James G. Baker. A treatment of the general problem of astronomical optics with numerous illustrations of the designing of specific types of instruments, both in theory and in practical details.

Photographic Photometry, Dr. Cecilia Payne-Gaposchkin and Dr. F. L. Whipple. A comprehensive discussion of the problems of photographic photometry found in the study of point-images, surfaces and spectra.

Opportunities for research under guidance will be available in the topics of the conferences and also in galaxies, astrophysics, variable stars, photoelectric photometry, meteors and meteorites.

Professor Shapley and Dr. Watson, assisted by visiting lecturers, will present a survey course, Introduction to Cosmogony. The lecturers will consider origins, processes and destinies; the subjects will include stars, galaxies, the structure of the universe, relativity, cosmic rays, the generation of stellar energy, ancient cosmogonies, mountain building, the age of the earth, planetary atmospheres and the origin of the solar system. Among the visiting lecturers will be: Professor Henry N. Russell and Professor H. P. Robertson, of Princeton University; Dr. Lyman Spitzer, Jr., of Yale University; Dr. R. E. Marshak, of Cornell University; Professor Kirtley F. Mather and Dr. I. A. Getting, of Harvard University, and Dr. Daniel Norman, of the Harvard Observatory. There will be two lectures and one discussion group each week.

As in 1939, auditors holding the degree of Ph.D. in astronomy, physics or mathematics will be allowed reductions in their fees. Further information can be obtained from the Harvard Observatory or from the Summer School Office, Wadsworth House, Cambridge, Mass.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

THE hundred and fifty-second annual meeting of the American Institute of Mining and Metallurgical Engineers was held from February 12 to 15, in the Engineering Societies Building, New York City, under the presidency of Donald B. Gillies, vice-president of the Republic Steel Corporation.

In addition to a full program of technical papers the events at the meeting included an "All-Institute" session, presided over by President Gillies, with the president-elect, Herbert G. Moulton, consulting mining engineer of New York City, as vice-chairman. Addresses were made by Colonel L. A. Codd, secretary of the U. S. Army Ordnance Association, and by Merlin H. Aylesworth, formerly utility executive-president of the National Broadcasting System.

At the directors' dinner on Tuesday evening Harvey S. Mudd, vice-president of the institute, presented four prizes, two of $100 and two of $50, in the first Institute National Student Contest.

The nineteenth annual lecture of the Institute of Metals Division was delivered on Wednesday by Edgar Hutton Dix, Jr., chief metallurgist of the Research Laboratories, Aluminum Company of America, on "Acceleration of Rate of Corrosion by High Constant Stresses." Following the dinner of the division on Thursday evening, Herbert T. Strong, color consultant of the New York Museum of Science and Industry, spoke on "Exploring the Magic World of Color." At this dinner the award of the division for 1940 was presented to Alden B. Greninger, assistant professor of metallurgy in the Graduate School of Engineering of Harvard University.

The seventeenth Howe Lecture was given on Thursday afternoon by Charles H. Herty, of the department of research and development of the Bethlehem Steel Company. He spoke on "Slag Control." Following the annual dinner of the Petroleum Division on Thursday evening, Herbert Hoover, Jr., of the United Geophysical Company, spoke on the "Economic Effects of Geophysical Exploration in the Petroleum Industry."

At a meeting of the Mining Geology Committee on Tuesday morning brief tributes were paid to the late Waldemar Lindgren by W. C. Mendenhall, B. S. Butler, Alan M. Bateman, W. H. Newhouse and R. D. Butler.

The medals and honors of the institute presented at the annual banquet at the Waldorf-Astoria on the evening of February 14 were:

The James Douglas Medal to Louis Davidson Ricketts, "for inspirational leadership and distinguished achievements in the metallurgy of copper."

The Anthony F. Lucas Medal to E. DeGolyer, "for initiating applied geophysics, directing the early practical seismic exploration and fostering applied science in finding, developing and producing oil."

The Robert W. Hunt Medal for 1940 to Axel Hultgren and Gösta Phragmén, for their paper, contributed to the institute, entitled "Solidification of Rimming-steel Ingots."

A certificate of honorary membership to Henry Krumb, vice-president of the institute for the last twelve years, "in recognition of his notable attainments as an engineer; of his constant and effective efforts in behalf of the profession; and of his never-failing and wise counsel in the administration of the institute's affairs during critical years."

The J. E. Johnson, Jr., Award to P. V. Martin, for his published research on the "Effect of the Solution-loss Reaction on Blast-furnace Efficiency."

Ninety living members of the institute have been on its rolls continuously for fifty years or more. Ten attained that status this year, thus becoming members of the Legion of Honor, Class of 1940, and receiving a special gold pin emblematic of the honor. They are: William R. Appleby, Henry C. Banon, Walter A. Barrows, Jr., L. E. Dunham, James MacNaughton, Spencer Miller, E. W. Parker, Franklin B. Richards, W. J. Richards and H. L. Smyth.

Herbert G. Moulton was introduced as president of the institute for 1940.

SCIENTIFIC NOTES AND NEWS

THE title of president emeritus has been conferred by the trustees of the Ohio State University on Dr. William McPherson, emeritus professor of chemistry, who has been acting president of the university since the retirement of Dr. George W. Rightmire nineteen months ago. The newly elected president, Dr. Howard Landis Bevis, previously William Ziegler professor of law and government in the Graduate School of Business Administration at Harvard University, has taken up his work at the university.

DR. EDWARD RAY WEIDLEIN, director of the Mellon Institute, was presented with the 1939 Pittsburgh Award by the Pittsburgh Section of the American Chemical Society at a dinner given in his honor at the University Club on February 15.

DR. WILLIAM CROCKER, director of the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., was the guest of honor at a surprise party given on January 27 by the staff of the institute in honor of his sixty-fourth birthday.

A DINNER was given recently by former students and friends of Dr. John F. Lyman, who has completed twenty-five years as chairman of the department of agricultural chemistry at the Ohio State University. Dean Emeritus Alfred Vivian, of the College of Agriculture, presided and made the presentation speech, to which Dr. Lyman responded. Gifts included a gold fountain pen, an engraved silver tray and a bound volume of letters from graduate students.

THE Council of the British Institution of Electrical Engineers has made the eighteenth award of the Faraday Medal to Dr. Alexander Russell, principal of Faraday House, London, a past president of the institution. The medal is awarded either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science.

DR. ERICH VON DRYGALSKI, professor of geography at the University of Munich, celebrated his seventy-fifth birthday on February 9.

LIEUTENANT COMMANDER F. W. REICHELDERFER, acting chief of the U. S. Weather Bureau, was elected

at the recent Columbus meeting *president* of the American Meteorological Society.

OFFICERS of the American Microscopical Society elected at Columbus on December 28 are: *President,* H. E. Jordan, University of Virginia; *First Vice-president,* Raymond J. Pool, University of Nebraska; *Second Vice-president,* Ruth Marshall, Rockford College, Illinois; *Secretary* (3 years), J. E. Ackert, Kansas State College; *Member of the Executive Committee* (3 years), Asa C. Chandler, Rice Institute.

THE officers for the American Association of Economic Entomologists for 1940 are: *President,* Professor Harry S. Smith, University of California; *First Vice-president,* Professor W. A. Price, Kentucky Agricultural Experiment Station; *Vice-presidents:* Pacific Slope Branch, B. G. Thompson; Cotton States Branch, O. I. Snapp; Eastern Branch, W. H. White; Section of Plant Quarantine and Inspection, George S. Langford; Section of Apiculture, Frank R. Shaw; Section of Extension, C. B. Dibble; Section of Teaching, C. L. Metcalf. *Branch and Section Secretaries:* Roy E. Campbell, Pacific Slope Branch; J. T. Creighton, Cotton States Branch; H. B. Weiss, Eastern Branch; Roger C. Smith, Section of Teaching; Roy G. Richmond, Section of Plant Quarantine and Inspection; W. A. Price, Section of Apiculture; G. E. Lehker, Section of Extension.

THE College of Physicians of Philadelphia has elected the following officers for 1940: *President,* E. B. Krumbhaar; *Vice-president,* O. H. Perry Pepper; *Secretary,* J. Harold Austin; *Treasurer,* John B. Flick; *Censors:* A. P. Brubaker, Charles W. Burr, Francis R. Packard and John H. Gibbon. *Incoming Councillors:* Robert H. Ivy and T. Grier Miller.

AT the meeting on January 11 of the Pathological Society of Philadelphia, the following officers were elected for 1940–41: *President,* Dr. Jefferson H. Clark; *Vice-president,* Dr. R. Philip Custer, and *Secretary-Treasurer,* Dr. Herbert L. Ratcliffe.

DR. RICHARD S. LYMAN, now of the Phipps Psychiatric Clinic of the Johns Hopkins University, has been appointed head of the new department of psychiatry and mental hygiene at Duke University, the establishment of which was made possible through a grant of $175,000 from the Rockefeller Foundation. The Highland Hospital, at Asheville, N. C., a gift to the university last year by Dr. Robert S. Carroll, will be used in connection with this department.

DR. LEON A. BRADLEY has been made head of the newly formed department of bacteriology at the Massachusetts State College. Merrill J. Mack, assistant professor of dairy industry, has been appointed to a full professorship.

THE London *Times* states that it is expected that Dr. E. G. Holmes, university lecturer in biochemistry, will be appointed deputy for the professor of biochemistry at the University of Cambridge from January 5 last to the end of the present academic year, and that he will be head of the department of biochemistry so long as he is deputy for that professor. Sir Frederick Gowland Hopkins, who occupies the professorship, has been ordered by his physician to rest.

LIEUTENANT COLONEL JAMES STEVENS SIMMONS, Medical Corps, United States Army, who for the past three years has been on duty as assistant corps area surgeon at headquarters, First Corps Area, Boston, Mass., was transferred on February 15 to the Professional Services Division of the Office of the Surgeon General, U. S. Army, Washington, D. C.

AT the business meeting of the Ecological Society of America recently held in Columbus, Dr. Thomas Park, of the University of Chicago, and Dr. Francis Ramaley, of the University of Colorado, were elected zoological and botanical editors, respectively, of *Ecology,* the journal of the society. They take the place of the former editors, Dr. Alfred Emerson and Dr. George Fuller, both of the University of Chicago.

DR. EDWARD L. KESSEL, chairman of the department of biology of the University of San Francisco, has recently been appointed managing editor of *The Wasmann Collector,* the official organ of the Wasmann Biological Society. Associated with him on the editorial board are Dr. Robert T. Orr, of the California Academy of Sciences; Roland Reed, S.J., of Alma College; Professors Harold A. Harper and Carl G. Kadner, of Loyola University of Los Angeles, and George W. Collins, of the University of San Francisco.

DR. ARCHIBALD V. HILL, Foulerton research professor in physiology and secretary of the Royal Society, has accepted the invitation of the Cambridge University Conservative Graduates' Association to be its candidate in the forthcoming parliamentary university by-election. He will stand as an independent conservative.

BOGDAN FILOV, minister of education of Bulgaria, professor of archeology and the history of art at the University of Sofia and president of the Bulgarian Academy of Sciences, has been called on to form a new Bulgarian Government owing to the resignation of the cabinet of Premier George Kiossewanoff.

DR. FREDERICK J. BRADY, of the U. S. Public Health Service, will spend several months in research in parasitology at the School of Tropical Medicine conducted at the University of Puerto Rico, San Juan, under the auspices of Columbia University.

ACCORDING to the *Journal* of the American Medical Association the following professors visited recently the medical centers of Argentina and gave lectures: Professors Rovenstine, of New York (anesthesia); Grey Turner, of London (surgery); G. Marañón, of Madrid; G. G. Voronoff, of Paris, and George Harrop.

ACCORDING to the London *Times* Professor Auguste Piccard and M. Max Cosyns, of Brussels, are going to Buenos Aires to cooperate with the committee which is arranging a balloon flight from Argentina into the stratosphere. The actual flight will be made by Major Olivera, of Argentina, and the Rev. Ignacion Puig, S.J., who is director of the Geodetic and Physics Observatory at San Miguel.

THE William Potter Memorial Lecture of the Jefferson Medical College of Philadelphia was delivered on February 14 by Dr. Irvin Abell, clinical professor of surgery at the University of Louisville School of Medicine. His subject was "The Spirit of Medicine."

DR. CHESTER S. KEEFER, associate professor of medicine at the Harvard Medical School, delivered the Henry Sewall Memorial Lecture before the Medical Society of the City and County of Denver on January 30. His subject was "Hemolytic Streptococcal Infections: Their Importance in Acute and Chronic Disease."

DR. GEORGE L. STREETER, director of the Carnegie Laboratories at the Johns Hopkins Hospital, visited the University of Minnesota Medical School on January 17 and 18. He lectured before the medical faculty and students on "Early Stages of Macaque Development and Their Significance in Primate Embryology."

THE Edward K. Dunham lectures of the Harvard Medical School will be given on March 4, 6 and 8 by Dr. S. Walter Ranson, professor of neurology and director of the Institute of Neurology of the Northwestern University Medical School, Chicago. The titles of the lectures are: "The Hypothalamus and the Sympathetic Nervous System"; "Hypothalamicohypophysial Relationships," and "The Hypothalamus and Behavior."

AT a meeting of the executive committee having charge of local arrangements for the meeting at Edinburgh of the International Congress of Psychology, it was decided that it would not be possible to hold the congress this summer. Edinburgh may still be regarded as open for some future year.

THE spring meeting of the Connecticut Valley Association of Psychologists, to be held on May 4 in New London, will mark the formal opening of the new psychological laboratory at Connecticut College. Professor Robert S. Woodworth, of Columbia University, will be the speaker. The laboratory is equipped with a vivarium, operating room, sound-reducing room, shop, darkroom, seminar and special research rooms.

A CONFERENCE of the entomologists of Maine and Canadian Maritime Provinces was held at the University of Maine on January 17 and 18. After a word of greeting from Dr. Fred Griffee, director of the Maine Agricultural Experiment Station, the conference was opened with a brief address of welcome by Dr. Arthur A. Hauck, president of the university. The program of the conference consisted of the informal presentation and discussion of problems concerning insects affecting truck crops, forest and shade trees and orchard and small fruits. At the final session it was decided to make such a conference an annual event.

THROUGH a bequest of the late William Campbell, for many years Howe professor of metallurgy at Columbia University, several fellowships have been established. They are awarded primarily for graduate study and research in the field of metallurgy. The stipend of each Campbell fellowship is fixed at the time of award by recommendation of the Campbell Fellowship Committee and will normally be an amount sufficient to meet the necessary living expenses of the incumbent of the fellowship. Further information can be obtained from Professor Eric R. Jette, School of Mines, Columbia University.

THE Graduate School of the University of Illinois has established four research fellowships to be awarded for one year in the fields of medicine and dentistry in Chicago at a stipend of $1,200 per year. Fellows are eligible for reappointment in competition with the new applicants. Candidates for these fellowships must have completed a training of not less than eight years beyond high school graduation. Applications must be made by March 1 to the secretary of the Committee on Graduate Work in Medicine and Dentistry, 1853 W. Polk Street, Chicago, Illinois.

NEW YORK UNIVERSITY GRADUATE SCHOOL OF ARTS AND SCIENCES announces the second annual New York University Social Science Field Laboratory Fellowships. The laboratory will be held among the Pomo Indians of California during the summer of 1940. The field work, editing and publishing of the results will be supervised by Dr. Bernard W. Aginsky, director, and Dr. Ethel G. Aginsky, associate director. The fellowships are limited to eight graduate students and accredited seniors who will be selected from several branches of the social sciences and from various universities. The purpose is to continue the investigation of the present white-Indian communities against the background of the aboriginal Pomo Indian culture in order to study culture change. The results, which may be used as theses or dissertations, are to be

published in a volume. Communications should be addressed to Dr. B. W. Aginsky, Sociology-Anthropology Department, Washington Square College, New York University, New York, N. Y.

THE Committee on the Chemistry of Proteins of the Division of Chemistry and Chemical Technology of the National Research Council has been granted $3,600 by Eli Lilly, of Indianapolis, for the establishment of a National Research Council fellowship in protein chemistry. The recipient of the fellowship is Dr. I. Fankuchen, who will carry on x-ray research on proteins in the laboratory of Professor B. E. Warren, at the Massachusetts Institute of Technology.

DR. GEORGE WASHINGTON CARVER, of the Tuskegee Institute, has given the sum of $33,000 to establish a foundation for chemical research. The foundation will be asked to preserve the Carver Museum at the institute, which contains an exhibit of the uses of native materials. The museum also will house about 100 paintings by Dr. Carver.

DISCUSSION

RAINBOWS AT HONOLULU

IN 1938, a note by Lobeck on lunar rainbows evoked several responses, and the present writer offered some statements as to frequent occurrence of both solar and lunar rainbows in Hawaii.[1] From October, 1938, to the end of November, 1939, record was kept of solar rainbows seen from a single automobile, official car number 529, driven about 850 miles per month, chiefly in morning and late afternoon hours. (See Table I.) About 90 per cent. were seen by the writer, the remainder by one or more of his assistants.

TABLE I

RAINBOW OBSERVATIONS

Month*	Rainbows recorded	Number of different half days (morning or afternoon)	Number of different days
1938			
October†	10	9	7
November	9	5	4
December	21	14	13
1939			
January	19	16	12
February	15	10	8
March	10	8	8
April	11	11	9
May	23	12	9
June	15	11	8
July‡	..	..	..
August§	4	3	2
September	16	12	10
October	27	17	11
November	21	11	9
Average for complete months ..	17.0	11.6	9.3

* These figures have no validity as showing long-term, seasonal differences for different months.
† 19 days, October 13–31.
‡ Absence from Honolulu, no record kept.
§ Part of month, record incomplete.

In the total, a new view of a rainbow, seen from a different district a few minutes later, was recorded as a separate observation; the amount of such duplication is readily seen in Table I. A similar number of rainbows would be seen by any one spending a fair number of days in the open; a substantially larger number by persons on a daily delivery schedule or at work in the open in particular districts. Following a note in the local papers, a number of contemporary and older observations of lunar rainbows were referred to the writer by letter and telephone, including statements as to prevalence nearly every lunar month at certain points, but statistical treatment is impracticable. In early October, 1938, while the writer was at Kilauea, Hawaii, a lunar rainbow was seen by numerous guests at the Volcano House.

CHESTER K. WENTWORTH

HONOLULU, HAWAII

[1] A. K. Lobeck, SCIENCE, 88: 187, 1938. Notes by W. J. Humphreys, R. L. Hightower and C. K. Wentworth, SCIENCE, 88: 496–498, 1938.

A TYPE SPECIMEN COMES HOME

THE type specimen of *Delphinus calvertensis*, after an absence of more than 90 years from the National Paleontological Collections, has been returned. As an example of true scientific interest and generous cooperation this recovery of an important type, whose ownership was obscured by the lapse of time and by the passing of an earlier generation, is an event of more than ordinary interest.

The history of this specimen is as follows:

In 1841, Francis Markoe, Jr., corresponding secretary of the National Institute, made a geological excursion into Calvert County, Maryland. From a cliff in the vicinity of Cove Point the skull and neck of a cetacean was collected. In 1842, this specimen was described by Richard Harlan,[1] who named it *Delphinus calvertensis*. In 1846, April 29th, the National Institute was directed by Congress to deposit its collections in the Smithsonian Institution. In 1850, Jeffries Wyman[2] announced that Louis Agassiz (who was appointed professor of natural history in Lawrence Scientific School of Harvard University in 1846) was commencing a study of the Cetacea. At a meeting of the American Academy of Arts and Sciences in October, 1848,[3] Professor Agassiz exhibited skulls of fossil cetaceans including the type of *Delphinus calvertensis*. In 1858, and 1862, the collections of the National Institute were transferred to the Smithsonian Institution,

[1] Richard Harlan, *Second Bull. Proc. Nat. Inst. for Promotion of Sci.*, Washington, D. C., 2, 195–196, figs. 1–4.
[2] Jeffries Wyman, *Am. Jour. Sci.*, 10: 230, footnote.
[3] *Proc. Am. Acad. Arts and Sciences, Boston*, 2: 5, 1852.

but this specimen was not among the materials received from that source. From the above chronological record, it is quite evident that the *Delphinus* skull was loaned to Professor Agassiz for use in his studies of the Cetacea and that it was in his custody when the actual transfer of National Institute specimens took place.

Recently the chronologic events in the history of this specimen were laid before Dr. Thomas Barbour, director of the Museum of Comparative Zoology in Cambridge, by Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution; the former acted promptly in having the specimen returned to the national collections. The type is in excellent condition and shows every evidence of careful handling throughout its unusual history.

C. W. GILMORE

U. S. NATIONAL MUSEUM

WAS THE AMERICAN MANO AND METATE AN INVENTION MADE DURING PLEISTOCENE TIME?

SEVERAL times since the writer discovered the deeply buried Gibson Site in January, 1930, he has found mano stones in the loose gravel below, and close to the bottom of the vertical bank containing the superimposed midden strata, at 24½, 27 and 30 feet below the present soil surface.[1] At this site in 1930 he found a mano stone immediately below a large hearth full of burnt stones, charcoal and a few man-made flint flakes. It lay in loose gravel as though it had just fallen out of the bank above. In 1936 another mano stone was found below the same bank. This mano has the same type of mineral incrustation which is found on the paleolithic type Abilene Points (Ray) found by the writer embedded in the 24½ feet deep stratum in the same site.[1,2]

Recently another visit was made to this site, where about two inches of what seemed to be a mano stone was seen exposed in the red clay, at a depth below the present soil surface of thirty feet. On excavating the stone, he found it to be a typical mano firmly embedded in the hard, red clay and charcoal stratum.

This is the same Gibson Site where in 1938 an elephas leg bone was shown to Dr. Kirk Bryan where it was embedded in gravel in the bank at a place a short distance farther up the creek.[3,4] This leg bone lay in a gravel stratum at approximately the same depth level and possibly in a later deposit than the silt in which the mano stone was embedded. Where the mano was excavated the gravel stratum lay six feet above it or at a depth of 24 feet below the surface. Where the proboscidian leg bone lay, at a place estimated to be about 1,500 feet up the course of Elm Creek, the gravel stratum which contained the leg bone lay at about the same depth as the mano, (30 feet).

In 1939 the writer dug out a mano and portions of a broken metate buried 19½ feet deep in a charcoal stratum at the Hodges Site. The writer dug back into the hard silt eighteen inches to find the whole mano and the metate fragments. At that site the grinding implements were in a stratum containing quantities of charcoal, burnt rocks, mussel shells and some flint flakes.

The Gibson Site is where the original discovery was made of the paleolithic type Abilene Points buried in a stratum of charcoal, burnt rocks and flint flakes at a depth of 24½ feet below the present soil surface.[1,2] Gibson Site is on Elm Creek, which is a branch of the Brazos River, near Abilene, Texas. Just above the top or 24½ feet deep midden level lies a hard compact stratum of gravel of an average thickness of about eight inches.

The three midden strata are imbedded in hard, compact red clay or silt below the gravel stratum. In 1934 the writer gave permission to E. B. Sayles to excavate in the Gibson Site for Gila Pueblo, and in their reports it is referred to as Stations 5 and 6. During that season several geologists inspected the site for Gila Pueblo, and among them were M. M. Leighton, of the Illinois Geological Survey. In Leighton's report, dated August, 1936, he divided the silts at this site into Elm and Durst silts. The lower or Durst silts he listed as Pleistocene in age in that report. A diagram of these is shown on page 9, Fig. 3, No. 1, of that report.[5] It was in the lowest or Durst level that the proboscidian leg bone was found in 1938, in the portion of the Gibson Site which Leighton terms Station 6. This year the mano stone was found in gravel in the same lower or Durst level in what he terms Station 5 of the Gibson Site.[6]

However, no one had found Pleistocene animal bones in the Gibson Site creek bank deposits prior to this writer's finding of a proboscidian's leg bone in July, 1938. The ancient Abilene Points (Ray) found here are in no wise similar to those listed under that name by others. The writer believes that the Abilene Points (Ray) are very much older.

In 1937 Gladwin stated that grinding tools were found in the Cochise culture, and placed their age at 10,000 B.C. The finding of a mano embedded in the

[1] Cyrus N. Ray, *Bulletin of Texas Archeological and Paleontological Society*, 2: 48–52, plates 11–14 and 15, 1930.

[2] *Ibid.*, 6: 107 to 111, plate 18, 1934.

[3] *Ibid.*, 10: 1, 269–273, plate 37, 1938.

[4] Kirk Bryan, *Bulletin of the Texas Archeological and Paleontological Society*, 10: 1, 273–274, plate 37, 1938.

[5] M. M. Leighton, "Geological Aspects of the Findings of Primitive Man near Abiline, Texas, Gila Pueblo, Globe, Arizona," pp. 16–20, Plate III-a, and Fig. 3, No. 1, 1936. (Stations 5 and 6 of Leighton's Report are his and Sayles's designations of the Gibson Site.)

[6] E. B. Sayles, *Medallion Papers*, No. xvii, Gila Pueblo, Globe, Arizona, 1935.

Durst silt extends this age back into the mists of Pleistocene time if Leighton's estimates of the age of the bottom layer of Elm Creek silts is correct.[7]

CYRUS N. RAY

THE TEXAS ARCHEOLOGICAL AND PALEONTOLOGICAL SOCIETY

AUTHORS' ABSTRACTS

SINCE it is now about twenty years since the *Astrophysical Journal* and the *Physical Review* began providing authors' abstracts at the beginning of articles, a brief report on the extent to which the practice has been adopted by other scientific journals may be of interest.

Authors' abstracts have been found of value both to readers and to abstract journals. As reported in SCIENCE,[1] answers to a questionnaire sent to the readers of the above journals in 1922 showed that 93 per cent. had found the abstracts useful and wished them to be continued. Two years later, at a meeting in Brussels, an international sub-committee of bibliography appointed by the League of Nations and including H. A. Lorentz (*chairman*), Madame Curie, Paul Langevin (editor of *Journal de Physique*) and Mr. Cooper (editor of *Science Abstracts*), recommended "that all articles published by scientific journals should be preceded by abstracts, prepared as far as possible by the authors themselves." That was fifteen years ago.

In the case of journals of physics, I am glad to be able to report that more than half now provide authors' abstracts. These include most American and British journals and also some Argentine, French, Italian, Spanish, Japanese and Russian journals. Unfortunately, the German journals have not yet adopted the practice and continue to provide only summaries, though these are not as convenient for readers, since they are placed at the end rather than at the beginning of articles, and are not as useful since they are not independent of the articles, as a rule, and are not suitable for reprinting in abstract journals.

The abstracts in the *Physical Review* from 1920 to 1925 were analytic abstracts, including subtitles intended to form precise and complete indexes of the new material contained.[2] While such abstracts are more efficient than ordinary abstracts, they have been found impractical since they require considerable editorial revision by a specialist. My zeal for perfection led me, as special abstract editor, to spend several thousand hours rewriting authors' abstracts, inserting sub-titles and making sure that they were accurate and complete. I am now convinced that such editorial work is not necessary.

Authors can prepare suitable abstracts for publication with their articles without much if any editorial revision. As evidence for this conclusion is the fact that the programs of the meetings of the American Physical Society have for many years contained abstracts which, although prepared by the authors and published without revision, are as a rule excellent. Obviously, authors can prepare equally good abstracts for publication with their articles if they will regard the abstract ***not as an introduction or summary associated with the article but as a separate entity like the abstract in an abstract journal.*** This view-point is difficult for an author to accept, since he naturally prefers to have his article read in full and dislikes furnishing an abstract which gives all the information which many readers desire about the article. Nevertheless, cooperation of authors can be obtained by all journals since it has been obtained by many. I am glad to report that the abstracts now being provided for articles in physics are adequate for the most part, as is proved by the fact that most of them are reprinted without change in *Science Abstracts*. In the volume for 1938 more than half of the abstracts of articles written in English are credited to the authors. Incidentally, this fact shows how important is the service authors' abstracts may render to abstract journals. If all the more than 100,000 scientific articles now published each year included adequate authors' abstracts, re-abstracting of the articles for the various abstract journals published in English, German, etc., would be unnecessary, and many trained scientists would be released from work which now must require some 500,000 hours of abstracting each year.

I must now admit that the rules I formulated for preparing analytic abstracts[2] are useful only to an expert. I am confident that editors can secure adequate authors' abstracts if they merely require authors "to prepare abstracts suitable for reprinting without change in an abstract journal." Authors are thoroughly familiar with such abstracts, and since they are naturally anxious that suitable summaries of their results appear in the abstract journals, they will prepare adequate abstracts, as a rule.

Authors' abstracts fill a gap between titles, which average ten words or less, and articles, which average several thousand words. They supply the needs of the many readers who wish to know more of what the articles are about than the titles tell, and of those who wish to know the main results without reading the articles. They also supply abstracts to the abstract journals, promptly and at minimum cost in the time of scientists. Thus they constitute an essential feature of an efficient system of scientific documentation. It is hoped that the time will soon come when all scientific journals will consider it their duty to provide authors' abstracts for all their articles.

GORDON S. FULCHER

CHEVY CHASE, MD.

[7] "Excavations at Snaketown," Vol. 2, p. 79. Gila Pueblo, Globe, Arizona, December, 1937.

[1] SCIENCE, 56: 678, 1922.

[2] SCIENCE, 54: 291, 1921.

SCIENTIFIC BOOKS

VIRUS AND RICKETTSIAL DISEASES

Virus and Rickettsial Diseases: With Especial Consideration of Their Public Health Significance. Harvard School of Public Health Symposium Volume. 907 pp. Cambridge, Mass.: Harvard University Press, 1940. $6.50.

IN June, 1939, a symposium on virus and rickettsial diseases was held at the Harvard School of Public Health. Rickettsial diseases were included in the symposium, according to Dr. Zinsser's statement in the foreword, "partly because there was until not so long ago a confusion between these conditions and those caused by virus agents. Indeed, in some quarters of the world such confusion still persists." The volume containing the record of the symposium consists of thirty-four papers, which deal with many subjects in the virus and rickettsial fields: epidemiology of virus diseases; nature of viruses; immunology of virus infections; insect vectors of virus diseases; variola; vaccine virus and vaccinia; measles; mumps; dengue fever; lymphogranuloma inguinale; absorption of materials from the respiratory tract; human and swine influenzas; canine distemper; psittacosis; poliomyelitis; a tentative classification of virus diseases of the central nervous system with a consideration of certain epidemic types of encephalitis; rabies; equine encephalomyelitis; lymphocytic choriomeningitis; louping ill; yellow fever; and finally a general survey, diagnosis, classification, clinical features, epidemiology and immunity of the rickettsial diseases. These subjects have been handled by the following workers: W. L. Aycock, K. D. Blackfan, H. D. Chope, C. K. Drinker, R. C. Eley, J. F. Enders, L. D. Fothergill, J. E. Gordon, R. A. Kelser, C. F. McKhann, J. R. Mote, J. H. Mueller, N. A. Nelson, H. Pinkerton, E. S. Robinson, R. A. Ross, F. F. Russell, A. W. Sellards, J. S. Simmons, C. Wesselhoeft, S. R. Wolbach, H. Zinsser.

An extensive field is covered by the symposium, and the development of knowledge about the diseases discussed has been very rapid during the last twenty years. Not only has the development of the knowledge been rapid, but for certain kinds of experimental work in the field special training is now required. Although knowledge of virus and rickettsial diseases has within the last two decades developed rapidly, orderly and comprehensive presentation of this knowledge to practising physicians and public health officers has lagged. There are several treatises on these diseases, for example, the one by Doerr and Hallauer and that by Levaditi and Lépine. These, however, were prepared more for highly trained workers in the field than for those not so intimately associated with the problems; and for that reason they do not fill the need admirably taken care of by the Harvard symposium. It is surprising that one medical school could marshal enough individuals to write attractively about so many different diseases. While many of them are authorities upon the subjects handled, others have had no first-hand knowledge of the material considered. However, in spite of this fact, papers by the latter group of authors are scholarly and provide adequate reviews of existing knowledge. If one desires an authoritative discussion of virus and rickettsial diseases without too much technical detail one would do well to read the book.

There are several chapters dealing with general subjects, *e.g.*, epidemiology, nature of the agents, immunity and insect vectors. In addition to the general chapters, there are many dealing with individual diseases. A survey of these diseases makes it obvious that those common to man or the diseases of lower animals that may affect man have been dealt with. For this reason the chapter on canine distemper appears to be out of place, and at least six diseases of human beings, some of which are important, have not been discussed, namely, molluscum contagiosum, herpes febrilis, varicella, herpes zoster, trachoma and inclusion blenorrhea. It is true that varicella and herpes zoster have not been definitely shown to belong to the virus group. However, the presumptive evidence is sufficient to include them in any discussion of virus diseases attacking human beings.

Inasmuch as the book was admittedly compiled for those who are not authorities in the virus and rickettsial fields, the authors should have been exceedingly careful to avoid mistakes which would be obvious to experts but misleading and confusing to the uninitiated. For the most part the material presented is correct and straightforward. However, certain inaccuracies have been observed, and a few of them will be mentioned. In the chapter on the properties of viruses considerable space is given to retrograde evolution in relation to the nature of viruses without noting the fact that Dr. Green, Dr. Gortner, Sir Patrick Laidlaw and others have already recorded similar views. The author dignifies his hypothesis with more experimental evidence than do the writers just mentioned, and for that reason the chapter is very interesting.

In the chapter on immunology of virus infections the dilution phenomenon (p. 94) is discussed. When a virus and its immune serum are mixed in a manner to obtain an inactive preparation, dilution of the preparation often results in its becoming active again, thus demonstrating the absence of a stable union between the virus and its neutralizing antibodies immediately after the mixture has been made. Schultz, Andrewes and Todd's experiments on this phenomenon are cited, but no mention is made of Bedson, who presumably was the first to show it in relation to virus diseases. Of

more importance, however, is the fact that no mention is made of later experiments by Andrewes and others which demonstrated an irreversible union *in vitro* between vaccine virus and its neutralizing antibodies; at least a vaccine virus-antiserum mixture kept *in vitro* for a period of time no longer yields active virus on dilution.

On page 98 the statement is made that "alexin fixation was the first *in vitro* virus reaction to be studied" and that Gordon in 1925 was one of the first to report alexin fixation and precipitation with vaccine virus. This statement is somewhat misleading, because Freyer in 1904 is considered to have definitely demonstrated that flocculation occurs in a mixture of vaccinia-immune serum and vaccine virus. Moreover, in 1906, Jobling demonstrated that complement is fixed in the presence of a mixture of vaccine virus and antivaccinal serum. Finally, Paschen, in 1913, reported that elementary bodies of vaccinia are specifically agglutinated by vaccinia-immune serum.

In the chapter on insect vectors of virus diseases, insect-borne virus diseases are tabulated (p. 137). In the first section of the table are placed diseases of insects that are insect-borne. It is true the diseases which are mentioned are maladies of insects, but they are not in the technical sense insect-borne. Indeed, the author on page 136 states that "the diseases may be transmitted either by inoculation or through the ingestion of contaminated food," thus indicating that he himself recognizes that they are not insect-borne infections.

In the chapter on epidemiology and the control of variola one finds the statement (p. 177): "We are still lamentably ignorant of the etiology of smallpox and of the behavior of the virus." It should be pointed out that those who are working with vaccinia and smallpox believe that they can recognize and identify with great accuracy the cause of these maladies.

The discussion of autopsy findings in generalized vaccinia in human beings (p. 220) is inadequate. The author should have consulted the excellent article on the "Histological and Experimental Observations upon Generalized Vaccinia in Man," by Dible and Gleave (*Jour. Path. and Bact.*, 38: 29, 1934).

The authors of chapters on measles do not handle equally well the discussion of experimental transmission of the disease to animals. Enders does it in a critical manner; he treats the work of Taniguchi in a satisfactory way, finally stating that this investigator probably in an accidental manner picked up vaccine virus in the process of his experiments on measles. McKhann, on the other hand, leaves the uninitiated with the idea (pp. 274–5) that perhaps Taniguchi successfully transmitted measles to rabbits and then back to man.

The chapter on distemper appears to have been prepared in a perfunctory manner. Indeed, there is no apparent reason for its inclusion in the book. Moreover, on page 519 the statement appears that Dunkin and Laidlaw proved in 1928 the primary cause of canine distemper to be a filtrable virus; the reference given is from *The Field, The Country Gentleman's Newspaper* of that year. As a matter of fact, Dunkin and Laidlaw first reported their splendid findings in three papers during 1926 in the *Journal of Comparative Pathology and Therapeutics.*

In the chapter on psittacosis it is stated (p. 529) that Krumwiede and his associates were among the first to show that psittacosis is caused by a filtrable virus. The statement is true, but to Bedson and his associates goes the credit of being the first to do it. Incidentally, the reference to Bedson's original work is not found in the bibliography. That white mice can be used for the experimental study of the disease is the important observation made by Krumwiede and his associates.

Confusion may result from the inclusion of Borna disease (pp. 662–3) in the group of encephalitides discussed in the chapter on equine encephalomyelitis. Borna disease is an encephalitis of horses, but it should not be included any more than rabies in this particular group. In the first place, the virus of Borna disease is 85–125 mμ in diameter, while that of the eastern and western equine encephalomyelitis is in the neighborhood of 20–30 mμ. In addition, other characteristics set Borna disease apart from the group of maladies under discussion.

Howitt is given credit (p. 691) for showing that a specific soluble antigen is responsible for complement fixation in the presence of lymphocytic choriomeningitis immune serum. She showed that complement fixation occurs, but it remained for Smadel and his associates to demonstrate that a soluble specific substance separable from the virus itself is responsible for the reaction.

The author of the chapter on etiology of yellow fever is too critical of laboratories in which accidental infections have occurred (p. 719). Perhaps he has forgotten that one of his laboratory associates contracted the disease and does not realize that the nature of the work carried on in different laboratories, instead of carelessness, may account somewhat for the differences in morbidity.

In the chapter on epidemiology of yellow fever (p. 737) the following statement appears: as a proved virus infection yellow fever has been known only since 1927. Exception should be taken to this, because Reed, Carroll, Lazear and Agramonte in 1900–1 proved by human experimentation that yellow fever is a virus disease. The work of Stokes, Bauer and Hudson in

1927, in which monkeys were used, thoroughly confirmed these findings and established for all time the virus nature of the malady.

The book is bound well. The paper is excellent. The type is large and easy to read. As a rule extensive bibliographies appear at the end of each chapter; the references have been well chosen, and those that have been checked are correct. The book is remarkably free from typographical errors. However, on page 691 Dr. Muench's name is misspelled, and on page 891, line 28, the word "protection" obviously should be "production."

One great fault to be found with the book is that it contains no index. This defect will decrease its usefulness for people who are not familiar with the subjects presented.

In spite of the errors and faults listed above, many of which are minor and relatively unimportant, the book as a whole provides a greatly needed discussion of diseases in a relatively new and very active field about which sufficient treatises for the practising physician and public health officer have not appeared. The part of the book dealing with rickettsial diseases is particularly good and one obtains the impression while reading it that experts in the field have taken a great deal of delight in presenting in a fascinating manner the results of their labors as well as those of their colleagues.

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CALIFORNIA SHRUBS

An Illustrated Manual of California Shrubs. By HOWARD E. MCMINN. xi + 689 pp. 775 figs. San Francisco: J. W. Stacey, Inc. 1939. $5.00.

"THE object of this volume," to quote the opening paragraph of the author's preface, "is to present a systematic and descriptive account of the shrubs of California which will serve as a working manual for their identification by the forester, ranger, traveler, vacationist, teacher, landscape designer, gardener and student of nature. While primarily planned for the use of the general public, the book has been written to serve also the professional botanist who is interested in the native shrubs of California."

This is a broad objective and difficult to accomplish, but in my opinion the author has succeeded admirably. The descriptions are clear and concise, and the keys are well arranged. Those not versed in technical botanical terms will find a glossary in the back and an abbreviated "Gray's Lessons" in the introduction. Ecologists and plant geographers will be interested in the discussion of the ecological classification of plants and the various shrub formations in California. A feature of the book that will be useful to those interested in cultivating native California plants is a chapter on the "use of California shrubs in garden design" contributed by Fred H. Schumacher. Some of the headings of this interesting chapter will suggest its character and scope: "Background Shrubs," "Accent Shrubs," "Ground Covers," "Shrubs for Hedges," "Shrubs for Rockeries and Wall Crevices," "Shrubs for Seaside Gardens," "Ornamental Fruits," "Woody Plants for the Perennial Border." Some 800 species and 200 varieties are recognized, and 775 of these are illustrated by text figures from line drawings or in the case of 20 species by full-page half-tones.

One familiar with the California flora will be surprised that a thousand species and varieties of "shrubs" are recognized, but the book is not limited to true shrubs. It also includes "woody vines, subshrubs, woody cushion plants and half shrubs." No doubt the clientele for whom the volume has been prepared will welcome the inclusion of these semi-woody plants, such for instance as 32 species of Penstemons, only 8 of which are really shrubs. The title is therefore a misnomer in that it understates the full scope of the work. But this is a refreshing fault, for many of our popular and semi-popular books on native plants err on the other side. Too often wild flower books and tree or shrub books are so titled that they give the impression that they cover all "America," whereas they include only those species found in the original thirteen colonies or some other restricted area.

One finds in scanning the pages that the floristic composition of the California lignescent flora (excluding trees) represents some sixty-five plant families. The families with twenty species or more are: Salicaceae (27), Polygonaceae (36), Saxifragaceae (34), Rosaceae (52), Fabaceae (46), Rhamnaceae (50), Ericaceae (58), Menthaceae (20), Scrophulariaceae (47), and Asteraceae (117). The genera having ten or more species are: Salix (27), Quercus (14), Eriogonum (36), Atriplex (18), Berberis (Mahonia) (10), Ribes (28), Lupinus (13), Ceanothus (40), Malvastrum (12), Arctostaphylos (38), Salvia (14), Penstemon (32), Lonicera (10), Haplopappus (21), Brickelia (13).

On the whole the author has maintained a conservative concept not only of species but of genera and families. His family "Fabaceae" includes Caesalpinaceae and Mimosaceae and is equivalent to the old "Leguminosae." Rosaceae and Saxifragaceae are also used in the broad sense. His conservatism in generic concept is illustrated by the combining of the American genus Hosackia with the Old World Lotus, Mahonia with Berberis and Ericameria with Haplopappus. One is surprised therefore to find Xylococcus separated from Arctostaphylos. I personally approve the segregation, but then I would also segregate Mahonia and Berberis, and Hosackia and Lotus.

The work is a serious attempt to foster a growing interest in native plant life, and we wish it well. For increased knowledge and wider intelligent interest in the native plants and the part they play in the economy of the state is imperative if we are to develop a sound scientific policy of conservation that will be supported by the public. Up to date the public's policy toward our national resources too often has been on a par with the recent economic policy of "spending ourselves rich."

LEROY ABRAMS

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REPORTS

FINANCES OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Is the American Association for the Advancement of Science in a sound financial condition? Its income statement and balance sheet of course answer that question. But they are in language we do not ordinarily use and consequently do not readily understand. Consequently I will make a few explanatory and supplementary remarks on the financial tables which follow.

The property of the association, aside from office equipment and supplies, consists primarily of its permanent funds, which are in the form of cash and securities, and title to SCIENCE and *The Scientific Monthly,* which were transferred to the association by Dr. J. McKeen Cattell in December, 1938. It will be seen on examining the balance sheet of the treasurer which follows that on last September 30 the investments of the association in securities and mortgages amounted to about $253,000. The portfolio of investments of the association has recently been examined by several groups of financial experts and pronounced on the whole satisfactory. However, the council at its meeting in Columbus elected Frederick P. H. Siddons, secretary of the American Security and Trust Company, of Washington, as chairman of the finance committee in order to provide the association expert advice on financial problems.

SCIENCE and *The Scientific Monthly* were sold to the association subject to a contract to pay to Dr. Cattell or his estate for ten years an annuity amounting to the average of half of the annual net profits of these journals for the five years preceding the date of their transfer. With the steadily increasing membership and circulation of the journals, these journals should be a source of substantial income, especially after payment for them shall have been completed. At that time, even if the membership of the association should not increase in the interval, they will exceed in value all other present assets of the association. The only serious hazard is that an inflation in this country will develop and greatly increase the cost of printing the journals.

TREASURER'S REPORT

Under the constitution of the association the treasurer is the custodian of the permanent funds of the association. The following balance sheet shows the assets and liabilities of the association, aside from the largely current assets and liabilities of the permanent secretary's office, which are contained in a separate report.

ASSETS (FROM TREASURER'S REPORT)

Securities and mortgages	$253,100.75
Cash available for investment	13,420.83
Cash available for current needs	16,082.67
Total assets	$282,604.25

LIABILITIES (FROM TREASURER'S REPORT)

Endowment (for research)	$115,761.45
Endowment (for general purposes)	95,838.38
Endowment (for emeritus life memberships)	5,000.00
Endowment (for emeritus annual memberships)	500.00
Reserve fund	36,941.61
Annual $1,000 prize fund	3,000.00
Unused grants to affiliated academies	435.00
Special gift	60.82
Permanent secretary's fund	12,480.14
Accumulated income not appropriated	12,586.85
Total liabilities	$282,604.25

It will be evident from this balance sheet that the treasury of the association is in a sound condition. The future will of course depend upon the income and expenses. The following table contains the cash receipts and disbursements of the treasurer for the year ended September 30, 1939, aside from cash received for called securities and cash paid out for purchased securities, and a few other small items not of a recurring nature.

CASH RECEIPTS (FROM TREASURER'S REPORT)

Income from investments	$ 9,466.43
For endowment, fees of new life members	5,000.00
Revertments from appropriations, etc.	101.06
Special gift	60.82
Total	$14,628.31

CASH DISBURSEMENTS (FROM TREASURER'S REPORT)

Grants in aid of research	$ 2,128.75
Grants to affiliated academies	2,615.00
Maiben lecture (Milwaukee meeting)	283.12
Life and 50-year member subs. to journals	1,668.00
Miscellaneous disbursements	116.89
Appropriation for emeritus life membership	4,500.00
Total	$11,311.76

These cash receipts exceeded the cash disbursements by $3,316.55. The treasurer also provided $1,000 for the Thousand Dollar Prize from reserves for the purpose.

In addition to the foregoing receipts and disbursements, the treasurer received $13,025 for bonds that had been called and disbursed $10,770.83 for securities

purchased by authority of the finance committee, leaving a balance of $5,570.72 in the treasury from the two items. After taking into account all the special non-recurring items, the cash in the treasury at the close of the year exceeded that at the beginning by $4,570.72. If this amount were all invested in securities, the income from it would barely make up for the loss of income due to the fact that securities purchased now bear considerably lower rates of interest than those which were retired.

PERMANENT SECRETARY'S REPORT

Under a provision of the constitution and by action of the council, the permanent secretary collects all dues of members and pays all operation expenses of the association.

The following is a condensed statement of income and expense of the office of the permanent secretary for the fiscal year ended September 30, 1939.

INCOME (FROM PERMANENT SECRETARY'S REPORT)	
Annual membership dues and fees	$93,803.50
Contributions from members	240.00
For journal subscriptions[1]	1,668.00
Interest and miscellaneous	681.40
Total income	$96,392.90

EXPENSE (FROM PERMANENT SECRETARY'S REPORT)	
Journal subscriptions, including foreign postage	$57,922.09
Salaries (8 persons)	20,237.05
Office equipment and supplies	720.75
Printing and stationery	1,553.33
Postage	2,171.50
Telephone and telegraph	134.78
Miscellaneous office expenses	531.74
General secretary's office	679.08
Treasurer's office	400.00
Allowances to Pacific and Southwestern divisions	2,256.00
Richmond meeting (net)	1,145.37
Milwaukee meeting (net)	1,921.32
Reserve for publication of proceedings	1,000.00
Miscellaneous section expenses	305.09
Travel expenses (exec. com. and perm. sec.)	516.44
Miscellaneous expenses	300.16
Circularization for new members	5,484.75
Total expense	$97,279.45
Deficit for fiscal year ended Sept. 30, 1939	886.55

By far the largest item of expense of the association is the subscriptions to SCIENCE and *The Scientific Monthly* for its members. Not all of this amount is an expense in the ordinary sense of the term, for a part of it is payment on the purchase of the journals and therefore in the nature of capital investment. The agreement between Dr. Cattell and the association does not define the amount of this advance payment in numbers, but it is several times the deficit. Consequently the operations of the association are not leading it into financial difficulties. It is hoped, however, that even on the present system of accounting there will be no deficit this year.

The items for printing, stationery and postage are also large, perhaps surprisingly large for those who have not thought through the necessary expenses for these things. Even to send out one letter to every member of the association costs about $1,600. From last October 1 to December 31 approximately 175,000 pieces of mail, or about 2,000 pieces daily, were sent out from the office of the permanent secretary, part of which was for circularization and part for the symposia of the association. The expenses for the latter are charged directly to the symposia accounts.

It will be observed that the meetings of the association cost substantial amounts after crediting them with the registration fees and the profit from the scientific exhibition, for the association is responsible for all expenses for arrangements and for providing equipment, both for its sections and for the societies that meet with it. This is one of its services to its affiliated and associated societies. Another is the sponsoring and publishing of symposia, the accounts for which are not included in these statements because they are special projects that are expected to be self-liquidating.

The foregoing statements will probably be clearer when reduced to the member basis. The natural question for the member is what becomes of the money he pays as dues. The following condensed table tells the story:

DISTRIBUTION OF MEMBER'S ANNUAL $5 DUES	
Journal	$3.000
Salaries, office of perm. sec.	1.002
Circularization	.272
Printing, stationery, postage	.184
Allowances to divisions	.112
Meetings (net)	.152
Reserve for proceedings	.049
Other expenses	.273
Total	$5.044
Deficit	0.044

There are several ways in which the deficit of 4.4 cents per member might have been avoided. For example, the large expenditures for circularization for new members might have been reduced, a question which will be discussed in a later report on membership. Or a larger percentage of the members of affiliated societies for which the association provided facilities at its meetings might have registered. Or, finally, the members who carelessly neglected to pay their duties until duplicate bills had been sent them might have paid them more promptly. In fact, if all members had paid their bills within three months of the time they were billed there would have been practically no deficit.

A question every member of the association may ask is whether his dues of a little less than 1.4 cents per day is a wise investment in his own satisfaction and in the advancement of science.

F. R. MOULTON,
Permanent Secretary

[1] From the treasurer for life members and emeritus members whose memberships are endowed.

SURVEY OF RESEARCH IN INDUSTRY

WITHIN the past few months the National Research Council has been requested by the National Resources Committee (now organized as the National Resources

Planning Board) to undertake a survey of scientific research in industry. This request was made of the Research Council as an operating agency of the National Academy of Sciences, since it is a basic function of the Academy, expressed in its Congressional Charter, to advise the Government upon scientific matters when called upon. The proposed examination of the research resources of industry is a part of a comprehensive plan of the National Resources Planning Board to study and evaluate the resources and facilities for scientific work in the United States in various types of institutions. A report, for instance, upon the research work of the Federal Government was published by the Board a year ago (entitled, "Research—A National Resource; I. Relation of the Federal Government to Research"). A similar survey is now in progress dealing with research in economics and the social sciences as developed in financial and commercial organizations of the country. The universities, also, constitute another major group of research agencies. A clarified understanding of the nature of the work that these several types of institutions are best equipped to do would, it is believed, contribute to the effective utilization of organized knowledge in the progress of industry and in service to society. The National Research Council has undertaken this survey of research in industry with the hope that the findings will be of benefit to science and of advantage to industry. Industry and business are clearly coming to depend more and more upon the use of scientific knowledge.

While the funds for the survey are to be provided by the National Resources Planning Board, the Council has been given full freedom by the Board as to the conduct of the survey. The study will consist not of a census of scientific men or of an inventory of equipment, nor yet of an enumeration of the projects of research in which industrial laboratories are now engaged. Rather it is desired to visualize the significant trends which the development of research has taken through these laboratories in various industries, many of which in newer fields are based largely on the direct application of scientific knowledge to manufacture. Discussion of the present relation of research to the growth of a number of the major industries will be included. Another portion of the survey will deal with the extent to which the recognized disciplines of science—physics, chemistry, mathematics, metallurgy, the several fields of engineering, biology and certain borderline fields—are applied in different industries. A history of the development of the research idea in industrial operations and certain economic aspects of the development of research in industry and a comparison of industrial research abroad with its growth in this country will also be included in the report.

In effect, the occasion of this survey is an opportunity for industries in which science is an integral part to undertake a critical and constructive scrutiny of the present utilization of science in manufacturing, in communications, in transportation and other fields of industrial activity. It is intended that the study be an untrammeled analysis of the situation, committed only to the purpose of encouraging the best use of science in relation to human welfare.

To take charge of this survey the Council has appointed a committee of which Mr. F. W. Willard, of the Nassau Smelting and Refining Company, is chairman. The committee is composed largely of industrial executives and research directors and representatives of universities active in industrial research. The immediate direction of the survey has been placed by the Council in the hands of Mr. Raymond Stevens, vice-president of the firm of Arthur D. Little, Inc., of Cambridge, Massachusetts. With him will be associated Mr. Dexter North, of Washington, D. C., and Dr. Caryl P. Haskins, president of the Haskins Laboratories, in Schenectady, New York, as assistant directors of the survey. A score or more of forward-looking men representing the interests of industrial laboratories, universities and special research institutions have been requested to prepare sections of the report. The report when approved by the Council is to be delivered to the National Resources Planning Board in printed form.

One feature of the survey will be the revision of the Directory of Industrial Research Laboratories, six editions of which have been issued by the National Research Council during the past twenty years. The last edition of the directory, presenting data for 1938, lists 1,769 industrial research laboratories in the United States, in which about 50,000 men are employed. The revision of this directory is being undertaken in connection with this survey in order to provide the factual data needed for the survey and to make available a more complete directory than any which has been issued heretofore. The compilation of the directory is at present the only statistical work being planned on an extensive scale in connection with the survey.

The membership of the Research Council's committee in charge of the survey is as follows:

F. W. Willard, *chairman*, president, Nassau Smelting and Refining Compaany, 50 Church Street, New York City.
C. L. Alsberg, director, Giannini Foundation of Agricultural Economics, University of California, Berkeley.
C. H. Bailey, professor of agricultural chemistry and vice-director, Agricultural Experiment Station, University of Minnesota, St. Paul.
Herbert A. Baker, president, American Can Company, 230 Park Avenue, New York City.
Henry A. Barton, director, American Institute of Physics, 175 Fifth Avenue, New York City.

L. W. Bass, assistant director, Mellon Institute of Industrial Research, Pittsburgh, Pa.

Carl Breer, director of research, Chrysler Corporation, Detroit, Mich.

O. E. Buckley, executive vice-president, Bell Telephone Laboratories, Incorporated, 463 West Street, New York City.

G. H. A. Clowes, research director, Eli Lilly and Company, Indianapolis, Ind.

W. D. Coolidge, director of research, General Electric Company, Schenectady, N. Y.

F. G. Cottrell, 3904 Ingomar Street, N. W., Washington, D. C.

M. H. Eisenhart, president, Bausch and Lomb Optical Company, Rochester, N. Y.

Charles N. Frey, director, Fleischmann Laboratories, 810 Grand Concourse, Bronx, New York City, N. Y.

George R. Harrison, professor and director of the Research Laboratory of Experimental Physics, Massachusetts Institute of Technology, Cambridge, Mass.

Maurice Holland, director, Division of Engineering and Industrial Research, National Research Council, New York City.

Harrison E. Howe, editor, *Industrial and Engineering Chemistry*, Mills Building, Washington, D. C.

Jerome C. Hunsaker, professor of aeronautical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Martin Ittner, research director, Colgate-Palmolive-Peet Company, Jersey City, N. J.

Frank B. Jewett, vice-president, American Telephone and Telegraph Company; president, Bell Telephone Laboratories, Incorporated, 195 Broadway, New York City.

John Johnston, director of research, United States Steel Corporation, Kearny, N. J.

Virgil Jordan, president, National Industrial Conference Board, 247 Park Avenue, New York City.

F. T. Letchfield, consulting engineer and assistant vice-president, Wells Fargo Bank and Union Trust Company, San Francisco, Calif.

L. W. Wallace, director, Division of Engineering and Research, Crane Company, Chicago, Ill.

E. R. Weidlein, director, Mellon Institute of Industrial Research, Pittsburgh, Pa.

Frank C. Whitmore, dean of the School of Chemistry and Physics, Pennsylvania State College, State College, Pa.

R. R. Williams, chemical director, Bell Telephone Laboratories, Incorporated, 463 West Street, New York City.

ROSS G. HARRISON,
Chairman, National Research Council

SPECIAL ARTICLES

THE INACTIVATION OF EPIDEMIC INFLUENZA VIRUS BY NASAL SECRETIONS OF HUMAN INDIVIDUALS[1]

CERTAIN difficulties have been encountered in attempting to explain susceptibility or resistance to epidemic influenza in terms of circulating antibodies to influenza virus. For example, some persons who possess little or no demonstrable antibody escape infection under the same conditions of exposure which result in the infection of other individuals with relatively high titers of neutralizing antibody. For this and other reasons, attention has been directed to the possibility that mechanisms resident in the respiratory tract itself might play a significant role in the prevention of the natural disease. An instance of local, non-immunological immunity was discovered while studying the processes of injury and repair in the respiratory mucous membrane of the ferret infected with influenza virus. It was found that, following the acute necrosis which occurs early in the disease, repair was associated with the formation of a squamous epithelium, which was refractory to further damage even by severe iontophoresis with zinc sulfate. This anatomical change was but a temporary one, although the tissues thereafter always exhibited the capacity of accelerated repair.[2]

[1] This study conducted under a grant from the International Health Division of the Rockefeller Foundation.

[2] T. Francis, Jr. and C. H. Stuart-Harris, *Jour. Exp. Med.*, 68: 789, 803, 813, 1938.

Over the last fifteen months the nasal secretions of human subjects have been studied to ascertain whether they possessed any capacity to inactivate epidemic influenza virus. Material from 31 patients in the first day or two of an acute afebrile common cold and from two hay-fever patients was collected by allowing the nasal discharge to drain directly into a bottle. The collections were ground individually with alundum and centrifuged. The supernatant fluid was removed, and 0.3 cc of it was mixed with 0.3 cc of a 1:2,000 suspension of mouse passage virus of the PR8 strain. After incubation at 37° C. for 30 minutes, 0.05 cc of the mixture, containing approximately 1,000 lethal doses of virus, was given intranasally to each of three mice. The mice were observed for ten days, all deaths recorded and the presence or absence of virus lesions in the lungs of survivors was determined at autopsy.

Secretions were obtained from fifteen normal individuals by inserting a loose pack of absorbent cotton well back into the nostrils until it became saturated. It was then removed and the clear liquid expressed. This material was tested in the same manner as the common cold secretions. Saliva from the normal individuals was also tested.

The degree of virus inactivation has been classified as complete when the mice survived without pulmonary lesions; almost complete, when the mice survived but exhibited only mild lesions; partial, when extensive

lesions were found, but the mice survived; no inactivation when the mice failed to survive the test period. On this basis the results are summarized in Table I.

TABLE I

INACTIVATION OF INFLUENZA VIRUS BY SECRETIONS OF HUMAN SUBJECTS

Secretions tested	Number of specimens	Degree of inactivation of virus			
		Complete	Almost complete	Partial	None
Common cold and hay fever	33	4	13	8	8
Normal	15	2	7	3	3
Saliva	16	0	1*	1*	14

* Negative when repeated 1 week later.

There was little difference between the results obtained with nasal secretions from patients with common colds and those from normal subjects. Approximately half caused complete or almost complete inactivation of 1,000 lethal doses of virus, while the other half exerted either slight or no inactivation. Saliva was ineffective. Secretions were obtained from six patients during the acute stage of a cold and again in a subsequent normal period. No significant differences were discernible in the results of the two tests. Of five samples of sputum from various patients, two caused partial inactivation; three had no effect.

The same phenomenon has been recently reported by Burnet, Lush and Jackson[3] who studied the action of nasal secretions of normal human subjects upon several viruses, including that of influenza. They noted no differences in the inactivating capacity of different specimens, but conducted their tests with filtered specimens. They state that the agent is destroyed at 100° C. Furthermore, they state that five hours is required for inactivation of virus to occur, and suggest that the agent is an enzyme.

Some characteristics of the inactivating agent have been outlined in the course of the present investigations. It is extremely stable at icebox temperature, remaining for at least six to eight weeks without change in potency. It is ineffective after heating at 70–75° C. for twenty minutes. In some cases, the material can exert its action after dilution, the extent of dilution varying with different samples. The highest effective dilution so far observed has been 1:8. The inactivation of virus by secretions is not the result of bacterial action, since many of the samples are either sterile or yield few colonies on blood agar plates. Furthermore, the bacteria, usually staphylococci, do not appreciably affect the test animals. The agent is not a lysozyme as measured by its action upon a susceptible micrococcus. In a series of tests with specimens exerting various degrees of inactivation upon the virus, the lysozyme content of the samples bore no parallelism to the virus-inactivating capacity but reached an approximate titer of 1:1,000 in each instance. The secretions have not been found to exert a bacteriostatic or bacteriolytic action when tested with smooth or rough pneumococcus, β. hemolytic streptococcus, *streptococcus viridans, staphylococcus aureus* or *albus, M. catarrhalis,* or meningococcus.

In the current study titrations of neutralizing antibody have been conducted in mice with serum from twenty of the patients with common colds and from all the normal subjects. While a sharp correlation between the inactivating effect of the nasal secretions and the antibody titer of the serum was not detected, it was found that the secretion from twelve of seventeen subjects with antibody titers of 1:20 or less gave either slight or no inactivation. The serum of four of the seven patients whose secretions failed to inactivate virus contained no antibodies; the other three had titers of 1:20. On the other hand, the secretions of sixteen of eighteen subjects, whose serum titers were 1:40 or more, completely or almost completely inactivated the test dose of virus. Within these broad limits a relationship is suggested. Furthermore, neutralizing antibodies in the serum are inactivated at the same temperature, 70–75° C., as the agent in the nasal secretions.

These studies are as yet incomplete. They show, nevertheless, that there exists in nasal secretions a substance capable of inactivating relatively large amounts of influenza virus. The inactivating capacity varies widely in different individuals, and in some respects resembles the so-called natural antibodies. It seems highly probable that this phenomenon is of considerable importance in relation to individual susceptibility to epidemic influenza.

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[3] F. M. Burnet, D. Lush and A. V. Jackson, *Brit. Jour. Exp. Path.*, 20: 377, 1939.

CHLOROPHYLL AS THE PROSTHETIC GROUP OF A PROTEIN IN THE GREEN LEAF[1]

IN an earlier publication,[2] it was pointed out that the differences in properties between chlorophyll dissolved in organic solvents and the green pigment as it exists in the leaf can be explained by assuming that the chlorophyll of the leaf is in combination with protein. It is now possible to present further information on the nature of this chlorophyll-protein compound.

The chloroplast material of ground-up spinach and

[1] This material was included in a paper under the same title which was presented at the photosynthesis symposium held at Columbus, Ohio, under the auspices of Section C of the American Association for the Advancement of Science on December 28, 1939.

[2] E. L. Smith, SCIENCE, 88: 170, 1938.

of Aspidistra has been purified by repeated salt precipitation or by differential centrifugation. Only about half this material is protein, as already found by Menke,[3] and now corroborated by us. To determine the ratio of chlorophyll to protein we estimated the protein chemically by the usual methods for N, and the chlorophyll spectrophotometrically by measuring the height of the absorption band in the red. Although the position of the absorption band in these preparations is different from that of chlorophyll in organic solvents, the same preparation has an identical extinction value in water as protein compound, or in ether or petroleum ether after precipitation of the protein with ten volumes of acetone. We have taken 5.4×10^4 as the value of the extinction coefficient estimated for three parts of chlorophyll *a* and one part of chlorophyll *b* from the values published by Zscheile.[4]

The measurements show a constant relation in the purified chloroplast material of about 16 parts of chlorophyll per 100 parts of protein. This indicates a little over three molecules of chlorophyll per Svedberg protein unit of 17,000 molecular weight. Because of the much smaller absorption at the standard wavelength of chlorophyll *b* compared to chlorophyll *a*, the fraction over 3 may represent an extra chlorophyll *b* molecule. This is in keeping with the observation of Willstätter and Stoll[5] that the leaves of most green plants show a ratio of about 3 to 1 of chlorophylls *a* and *b*. This constant stoichiometric combination of protein and chlorophyll strengthens the conclusion from other evidence that chlorophyll acts as the prosthetic group of a protein.

As stated earlier,[2] the chlorophyll-protein compound can be rendered water-soluble by the action of various detergents such as digitonin (= digitalin), bile salts or sodium desoxycholate. We have studied the action of an additional detergent, sodium dodecyl sulfate (SDS), in some detail. In addition to clarifying completely the green pigment, SDS also quantitatively converts the chlorophyll into phaeophytin, *i.e.*, removes magnesium from the molecule. This conversion, measured spectrophotometrically, proceeds at a rate which is directly proportional to the hydrogen-ion concentration, and takes place even in fairly alkaline solutions (pH 8 to 9). At constant pH, the rate is proportional to the SDS concentration until a maximum rate is achieved. Phaeophytin formation does not occur in 4 per cent. digitonin, or 10 per cent. bile salts at pH 4.5. At this pH, in 0.05 per cent. SDS the reaction is complete in a few minutes. It is therefore apparent that different detergents may have quite different actions on the same compound.

In the presence of SDS, the chlorophyll or phaeophytin (depending on the pH of the solution) remains attached to the protein, since the prosthetic group can not be separated by ultrafiltration, dialysis or by salt precipitations after removal of the SDS. This is confirmed by an ultracentrifugal study[6] of the solutions, which shows in addition that the protein is split into smaller units than in the other detergents. The action of SDS on the chlorophyll-protein compound of spinach differs from its action on the virus of tobacco mosaic disease; in the latter case, Sreenivasaya and Pirie[7] showed not only a splitting of the protein, but also a separation of the prosthetic group (nucleic acid) from the protein.

The fact that the phaeophytin remains attached to the protein indicates that in the smaller units magnesium plays no role in binding chlorophyll to the protein. The magnesium may, however, be concerned in the binding of the larger units, as indicated by the ease with which it is eliminated when the protein is split.

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VITAMIN B_6 AS AN ACCESSORY GROWTH FACTOR FOR STAPHYLOCOCCUS ALBUS[1]

IT has been shown recently by Knight[2] that *Staphylococcus aureus* can be grown on a synthetic amino acid medium provided it contains nicotinic acid and thiamin. Koser, Finkle, Dorfman, Gordon and Saunders,[3] using *Staphylococcus albus*, have reported somewhat similar but less striking results. The present communication reports the result of a study to determine whether or not synthetic vitamin B_6[4] (2-methyl, 3-hydroxy, 4,5-di-[hydroxymethyl] pyridine) has any effect on *Staphylococcus albus*[5] grown in a synthetic amino acid medium.

[3] *Zeits. physiol. Chem.*, 257: 43, 1938.

[4] *Bot. Gaz.*, 95: 529, 1934. When the data of Winterstein and Stein (*Zeits. physiol. Chem.*, 220: 263, 1933) are converted from log $_e$ to log $_{10}$ by dividing by 2.303, they are in good agreement with those of Zscheile. The data of Rabinowitch and Weiss (*Proc. Roy. Soc. London*, A, 162: 251, 1937) have somewhat lower values.

[5] "Investigations on Chlorophyll," English translation by F. M. Schertz and A. R. Merz, Washington, D. C., 1928.

[6] E. L. Smith and E. G. Pickels, unpublished.

[7] *Biochem. Jour.*, 32: 1707, 1938.

[8] Present address: Connecticut Agricultural Experiment Station, New Haven, Conn.

[1] From the Department of Internal Medicine, University of Cincinnati College of Medicine and the Cincinnati General Hospital. This investigation was aided by a grant from the John and Mary R. Markle Foundation.

[2] B. C. J. G. Knight, *Biochem. Jour.*, 31: 731, 1937.

[3] S. A. Koser, R. D. Finkle, A. Dorfman, M. V. Gordon and F. Saunders, *Jour. Infect. Dis.*, 62: 209, 1938.

[4] Supplied through the courtesy of Merck and Company, Inc., Rahway, N. J.

[5] This culture was furnished through the kindness of Dr. Arnold G. Wedum, University of Cincinnati.

Medium IV of Koser and associates[3] was used first and was later modified by the addition of 0.2 gms NaCl and 1.2 gms asparagine per liter.

Repeated observations have shown that vitamin B_6, in amounts of 0.3 to 1.2 gamma per cc stimulates the growth and acid production of *Staphylococcus albus* when nicotinic acid and thiamin are present.

S. P. VILTER
T. D. SPIES

SCIENTIFIC APPARATUS AND LABORATORY METHODS

GRAPHICAL METHOD FOR DETERMINING WARBURG VESSEL CONSTANTS AT VARIOUS FLUID VOLUMES

IN the use of the Barcroft-Warburg manometer for studies on cell and tissue metabolism it is frequently necessary to know the value of the vessel constant, k, for a number of different values of V_F, the volume of liquid in the vessel, under otherwise constant experimental conditions. The vessel constant is ordinarily obtained by calculation from the well-known formula:

$$k = \frac{V_G \frac{273}{T} + V_F \alpha}{P_o}. \qquad (1)$$

where V_G is the volume of gas space in the vessel containing a volume of liquid V_F, both volumes being expressed in cubic millimeters; T is the absolute temperature of the thermostat; α is the absorption coefficient at the experimental temperature for the gas concerned; and P_o is the number of millimeters of manometer fluid equivalent to one atmosphere of pressure.

This calculation is somewhat tedious if there are a number of vessels concerned, and there is always the possibility of an unsuspected numerical error somewhere in the computation. We have found it much more convenient to use a graphical presentation of the relation between k and V_F, as shown in Fig. 1. In this graph the values of k_{O_2} and k_{CO_2} for a given vessel and experimental temperature are plotted on ordinary cross-section paper against various values of V_F. It can be seen that the relation between k and V_F is strictly linear, and that it is a simple matter to obtain the vessel constant for oxygen or carbon dioxide at any desired value of V_F, particularly when V_F is not a simple whole number.

The linear relationship between k and V_F is not readily evident from equation (1), since V_G is a function of V_F, but if it is recalled that $V_G = V_T - V_F$, where V_T is the total vessel volume as obtained in the usual calibration with mercury, equation (1) may be written:

$$k = \frac{(V_T - V_F)\frac{273}{T} + V_F \alpha}{P_o} \qquad (2)$$

from which the following equation may be obtained:

$$k = \frac{V_T}{P_o} \cdot \frac{273}{T} - \frac{V_F}{P_o}\left(\frac{273}{T} - \alpha\right) \qquad (3)$$

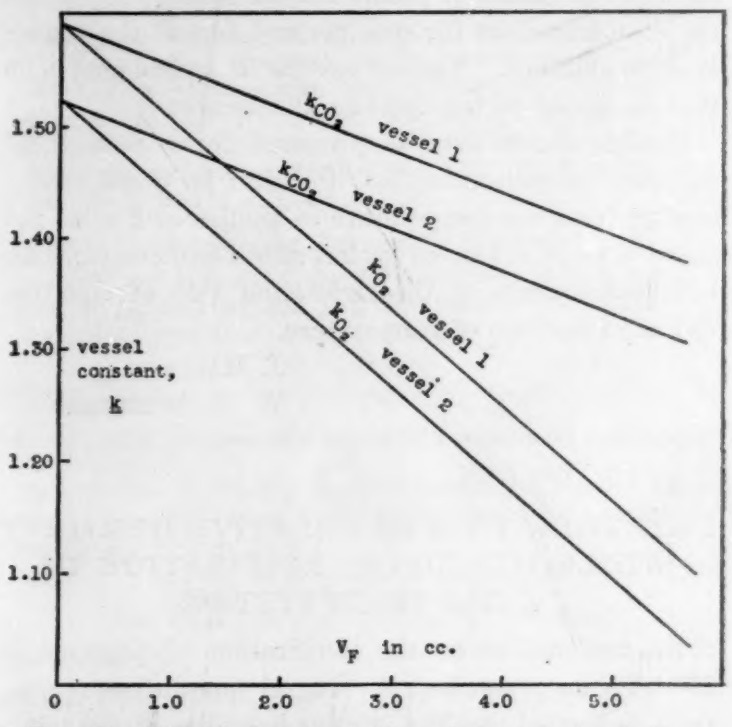

FIG. 1. Graphical presentation of the relation between the vessel constant, k, and the amount of liquid in the vessel, V_F, for two different vessels and for both oxygen and carbon dioxide.

Equation (3) is of the form $y = a - bx$ and expresses a linear relationship between k and V_F, since under ordinary conditions the other components of the equation are constants.

It will be noted that for a given temperature and manometer fluid the slope of the curve is determined by the solubility of the gas concerned, while the intercept on the y axis is determined by the vessel volume, V_T. Thus for a given vessel the curves for different gases will all start from the same point on the y axis, differing only in their slope, as shown in Fig. 1, while for a number of vessels the curves for a particular gas will all be parallel and will differ solely in their intercept on the y axis. It is thus a simple matter to plot the curves for a number of vessels, and for several different gases, on a single sheet of cross-section paper, and to read off at a moment's notice the value of the vessel constant for a particular vessel, gas, and V_F value.

To construct the curves for a number of vessels, the simplest procedure is to establish the intercept on the y axis for each vessel by dividing the value of V_T for the vessel (in cu. mm) by P_o, and multiplying the result by the value of 273/T. These points are laid

out along the y axis, and then for a single vessel and a particular gas the slope of the curve is established by determining from equation (2) the value of k at an arbitrary value of V_F (*e.g.*, 5,000 cu. mm or 5.0 cc), and plotting this point on the chart. A straight line through this point and the corresponding intercept point gives the calibration curve for the particular vessel and gas. Lines parallel to this are now drawn through the intercept points for the other vessels, and the complete chart for one gas and for all the vessels is thus obtained. The curves for a second gas may then be drawn on the chart in like manner.

Similar charts may be prepared for a number of different temperatures, but it should be noted that a change from one temperature to another will alter not only the slope of the curves but also the intercept, since both components of the right-hand side of equation (3) are functions of temperature.

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DETERMINATION OF RELATIVE HUMIDITY WHILE MEASURING RESPIRATION IN A GAS TRAIN SYSTEM[1]

RECENT studies on the sterilization of papayas at 110° F., as prescribed by federal quarantine regulations, indicated that the relative humidity of the treating medium was of distinct importance. For instance, it was found that at approximately 100 per cent. relative humidity the fruits were severely injured, while if the humidity was lowered to 80 per cent., injury did not occur. Hence, in conducting respiration studies it was considered desirable to measure the relative humidity with the accuracy of a sling psychrometer and yet enclose the psychrometer in the gas train. The apparatus shown in Fig. 1 served this purpose. It is constructed from a glass tube 25 mm in diameter and approximately 100 mm long. Two openings in the tube take No. 0 stoppers to hold the thermometers, and a small bulb blown opposite one of the openings serves as a reservoir for the wet bulb thermometer. The ends are brought down to a diameter of 8 mm and tubing of this size is sealed to each end. The apparatus is then sealed in the gas train system and may be immersed in a water bath at any desired temperature. The air in this apparatus should be circulated at a speed of approximately 15 feet per second to obtain accurate readings on the wet bulb.

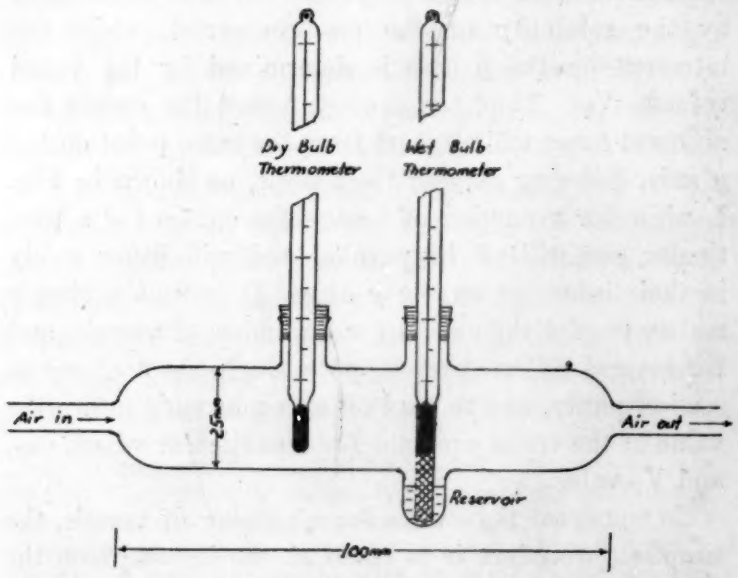

FIG. 1

[1] Published with the approval of the director as Technical Paper No. 54, Hawaii Agricultural Experiment Station.

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HONOLULU

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